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INTERACTIONAL AERODYNAMICS OF THE SINGLE ROTOR HELICOPTER CONF--ETC(U)

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INTERACTIONAL AERODYNAMICS OF THE SINGLE  
ROTOR HELICOPTER CONFIGURATION

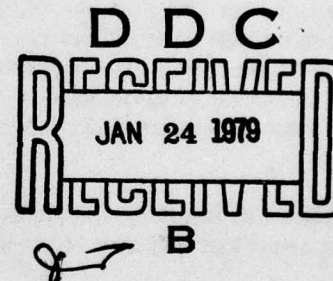
VOLUME IV-A - One-Third Octave Band Spectrograms of Wake  
Split-Film Data, Buildup To Baseline

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Prepared for

APPLIED TECHNOLOGY LABORATORY

U. S. ARMY RESEARCH AND TECHNOLOGY LABORATORIES (AVRADCOM)

Fort Eustis, Va. 23604

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### APPLIED TECHNOLOGY LABORATORY POSITION STATEMENT

In 1975 a wind tunnel test program was conducted in the Boeing-Vertol 20-foot V/STOL Wind Tunnel on a 1/5th-scale UTTAS model to investigate and find solutions for several aerodynamic problems encountered during the UTTAS flight-testing. Specifically, these tests focused upon (a) the structure of the hub/rotor wake in the vicinity of the empennage, (b) the formulation of the ground vortex and its relation to hub loads and fuselage loads during transition, and (c) the occurrence of vibratory air pressures from the blade passing over the fuselage. Only portions of the above-mentioned wind tunnel test data were reduced and analyzed in addressing the flight-test problems of the UTTAS aircraft.

Under Contract DAAJ02-77-C-0020, Boeing-Vertol completed analyses on the data to understand more completely the aerodynamic interactions that are involved and to formulate instructions for the guidance of designers in these respects. The results of these studies are applicable to all existing and future single-rotor/tail rotor helicopters. The data have been segregated according to aerodynamic interactions and associated phenomena/problem areas. From this body of knowledge, a generalized set of design guidelines meaningful to the single-rotor helicopter design concept formulation were developed and are included in these reports.

Mr. Robert P. Smith of the Aeronautical Technology Division, Aeromechanics Technical Area, served as project engineer for this effort.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This is the first of the seven sub-volumes of Volume IV containing one-third octave band spectrographs of the model helicopter hub/rotor wake as it was modified by various aerodynamic devices. This sub-volume deals with the wake changes as the model is built up to the baseline configuration.			

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## PREFACE

The entire report describing the investigation of **INTERACTIONAL AERODYNAMICS OF THE SINGLE-ROTOR HELICOPTER CONFIGURATION** comprises eight numbered volumes bound as 33 separate documents. The complete list of these documents is as follows:

### Volume I, Final Report

### Volume II, Harmonic Analyses of Airframe Surface Pressure Data

- A — Runs 7-14, Forward Section
- B — Runs 7-14, Mid Section
- C — Runs 7-14, Aft Section
- D — Runs 15-22, Forward Section
- E — Runs 15-22, Mid Section
- F — Runs 15-22, Aft Section
- G — Runs 23-33, Forward Section
- H — Runs 23-33, Mid Section
- I — Runs 23-33, Aft Section

### Volume III, Flow Angle and Velocity Wake Profiles in Low-Frequency Band

- A — Basic Investigations and Hubcap Variations
- B — Air Ejector Systems and Other Devices

### Volume IV, One-Third Octave Band Spectrograms of Wake Split-Film Data

- A — Buildup to Baseline
- B — Basic Configuration Wake Explorations
- C — Solid Hubcaps
- D — Open Hubcaps
- E — Air Ejectors
- F — Air Ejectors With Hubcaps; Wings
- G — Fairings and Surface Devices

### Volume V, Harmonic Analyses of Hub Wake

### Volume VI, One-Third Octave Band Spectrograms of Wake Single Film Data

- A — Buildup to Baseline
- B — Basic Configuration Wake Exploration
- C — Hubcaps and Air Ejectors

### Volume VII, Frequency Analyses of Wake Split-Film Data

- A — Buildup to Baseline
- B — Basic Configuration Wake Explorations
- C — Solid Hubcaps

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- ## Volume VIII, Frequency Analyses of Wake Single Film Data

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## INTRODUCTION

Volume IV presents spectrograms of the flow angles and velocity components for each run and its test points. Specifically, these machine plots show the root mean square value of each wake parameter over discrete frequency intervals one-third of an octave band in width. The octave arrangement is selected to provide 19 spectral increments from 3.9 to 250.0 Hz centerband frequency. A special computer program is employed to derive wake parameters within these bands consistent with corresponding basic spectral functions depicted in Volume VII.

The graphs showing the one-third octave band values are sequenced in the same order as the Outline of Wake Investigations (Table 1). These graphs are distributed among Volumes IV-A through IV-G by the major categories of Table 1 in the following arrangement:

Volume IV-A	Build-up to Baseline
Volume IV-B	Basic Configuration
Volume IV-C	Effect of Hub Caps Section 1 & 2
Volume IV-D	Effect of Hub Caps Section 3 & 4
Volume IV-E	Effect of Hub Caps Section 5 and Effect of Air Ejectors
Volume IV-F	Air Ejectors with Open Hub Caps and Effect of Wings and Misc. Section
Volume IV-G	Effect of Wings and Misc. Sections 2 and 3

The Table 1 outline and other material is included for reference and as a context to the work of each sub-volume. Table 2, the List of Test Runs, arranges the runs in numerical order and gives pertinent text parameters.

The Index of Rake Positions, Table 3, lists the hot film transducer rake positions in the model coordinate system for each run and its test points. The main feature of Table 3 is the indexing of the test point number to the model waterline station and butt line as it varied from run to run. The table groups the runs as they shared the indexing correspondence of point with position. It is emphasized that the runs in a group do not necessarily all share the same number of test points but they do have same correspondence within their respective ranges of test points.

The orientation of the rake is shown pictorially in Figures 1 through 6 for the various test runs. Figure 7 presents a scaled drawing of the model with reference to the three-axis coordinate system. Table 4 lists the center frequency and the upper and lower band limits for each of the numbered one-third octave bands.

TABLE 1			
OUTLINE OF WAKE INVESTIGATIONS			
Description	Configuration Code	Run No.	Base-line
<u>Build-up to Baseline</u>			
1. Nacelles removed	$K_{13}+H_1-N$	149	150
2. Blades off, rotating hub	$K_{13}-M+H_{1.0}$	160	156
3. " " , non-rotating hub	$K_{13}-M+H_{1.0}$	158	156
4. " " , hub off	$K_{13}-M-H_{1.0}$	159	156
<u>Basic Configuration</u>			
<u>1. Wake Explorations near Empennage</u>			
(a) 15" Long. + traverse at T/R C.L.	$K_{11}$	111	---
(b) 9" Vert. + " above T/R "	"	112	---
(c) 2" " " in vortex	"	113	---
(d) 8" " " (continue 112)	"	114	---
(e) 13" " " behind stab.	"	115	---
(f) Lateral traverse, left stab. (One T.P. only)	"	116	---
(g) Same continued	"	117	---
(h) Same continued (One T.P. only)	"	118	---
(i) Lateral traverse right stab.	"	119	---
(j) T/R effect on wake	$K_{11}+T_2^0$	121	115
<u>2. Climb/Descent Studies</u>			
(a) Climb 900 FPM	$K_{11}$	135	---
(b) Descent 800 FPM	"	136	---
<u>Effect Of Hub Caps</u>			
<u>1. Solid Caps on Canister</u>			
(a) 7.6" diam. 2.17" ht. soft Pitch Arms	$K_{11}-H_{1.0}+H_{1.2}$	137	136
(b) 7.6" diam. 2.17" ht. stiff Pitch Arms	$K_{13}+H_{1.2}$	153	156
(b) 7.6" diam. 2.45" ht. flt. test config.	$K_{13}+H_{1.2.1}+I_1$ $+E_{1.0}$	207	188

TABLE 1 (CONTINUED)

## OUTLINE OF WAKE INVESTIGATIONS

Description	Configuration Code*	Run No.	Base-line
<u>Effect of Hub Caps (Continued)</u>			
2. <u>Solid Caps Raised Above Canister</u>			
(a) 7.6" diam. 2.45" ht. 70" depth, .55 gap	H <sub>1.2.2</sub> +I <sub>1</sub> +E <sub>1.0</sub>	208	188
(b) 10.0" diam. 3.25" ht. 1.55" depth, .50" gap	H <sub>1.8.1</sub> +I <sub>1</sub> +E <sub>1.0</sub>	189	188
(c) 10.0" diam. 4.125" ht. 2.05" depth, .875" gap	H <sub>1.8.2</sub> +I <sub>1</sub> +E <sub>1.0</sub>	190	188
(d) Repeat of 189	" " "	210	188
3. <u>Open Caps Without Underbody</u>			
(a) 10.0" diam. 1.25" gap, blades	H <sub>1.0.2</sub> +I <sub>1</sub> +E <sub>1.0</sub>	193	188/166
(b) " " " gap, no blades	H <sub>1.0.1</sub> -M <sub>1</sub> +E <sub>1.0</sub>	166	158
(c) " " 2.05" gap, blades	H <sub>1.14.1</sub> +I <sub>1</sub> +E <sub>1.0</sub>	211	188
(d) " " 1.75" gap, no blades	H <sub>1.0.1</sub> -M	165	158
(e) " " 1.87" gap, blades	H <sub>1.0.3</sub> +I <sub>1</sub> +E <sub>1.0</sub>	191	188
(f) 16" diam. 2.00" gap, blades	H <sub>1.7.1</sub>	168	156/167
(g) " " " gap, no blades	H <sub>1.7.1</sub> -M	167	158
(h) " " 4.00" gap, blades	H <sub>1.7.2</sub>	169	156
4. <u>Open Caps with Underbody</u>			
(a) 7.6" diam. 1.25" gap	H <sub>1.11.1</sub> +I <sub>2</sub> +E <sub>1.0</sub>	194	188
(b) " " " "	H <sub>1.11.1</sub> +I <sub>2</sub> +E <sub>4.0</sub>	198	188
(c) " " " " center post	H <sub>1.11.2</sub> +I <sub>2</sub>	202	194
(d) 10.0" diam. .5" gap, no blades	H <sub>1.5.1</sub> -M	164	158
(e) " " 1.25" gap, no blades	H <sub>1.5.2</sub> -M	161	158
(f) " " 2.0" gap, no blades	H <sub>1.5.4</sub> -M	163	158
(g) " " 4.0" gap, no blades	H <sub>1.5.3</sub> -M	162	158
(h) " " 1.25" gap	H <sub>1.5.2</sub>	154	156/161
*Basic Code is K13.			



TABLE 1 (CONTINUED)

## OUTLINE OF WAKE INVESTIGATIONS

Description	Configuration Code*	Run No.	Base-line
<u>5. Miscellaneous Hub Covers</u>			
(a) Hub fairing 16" diam.	H <sub>1.3</sub>	151	150
(b) Wham-O-Frisbee 10" diam.	H <sub>1.9.0</sub> +E <sub>1.2</sub>	182	181
(c) Fab. glass Frisbee 16" diam.	H <sub>1.9.1</sub> +E <sub>1.2</sub>	183	181
<u>Effect of Air Ejectors</u>			
1. Basic system no blowing	H <sub>1.0</sub> +E <sub>1.0</sub>	172	156
2. " " 40 psi	" "	173	156/172
3. " " 150 psi	" "	174	156/172
4. Wide chord shroud 40 psi	H <sub>1.0</sub> +E <sub>2.5.1</sub>	175	156/173
5. Wide " " 150 psi	" "	176	156/174
6. W/C shroud w. lip 40 psi	H <sub>1.0</sub> +E <sub>3.5.2</sub>	184	156/173
7. Same Contoured Parallel 150 psi	H <sub>1.0</sub> +E <sub>3.5.4</sub>	187	156/174
8. Bifurcated duct 0 psi	H <sub>1.0</sub> +E <sub>5.0</sub>	203	156
9. " " 40 psi	" "	204	156/203
10. " " 150 psi	" "	205	156/203
<u>Air Ejectors with Open Hub Caps with Underbodies</u>			
1. 7.6" diam. 1.25" gap, 0 psi	H <sub>1.11.1</sub> +I <sub>2</sub> +E <sub>1.0</sub>	194	188/172
2. " " " " 20 psi	" " "	195	188
3. " " " " 40 psi	" " "	196	188/173
4. " " " " 150 psi	" " "	197	188/174
5. " " " " 0 psi	H <sub>1.11.1</sub> +I <sub>2</sub> +E <sub>4.0</sub>	198	188/194
6. " " " " 40 psi	" " "	199	188/196
7. " " " " 150 psi	" " "	200	188/196
8. Same with center post	H <sub>1.11.2</sub> +I <sub>2</sub> +E <sub>4.6</sub>	201	188/200
9. 10.0" diam. 2.0" gap wide ch'd shroud (150 psi)	H <sub>1.5.4</sub> +E <sub>2.5.1</sub>	177	156/176
<u>Effect of Wings and Misc.</u>			
1. Wings			
(a) Nacelle-mounted stub wing	H <sub>1.0</sub> +W <sub>1.0</sub> +E <sub>1.1</sub>	178	181
(b) Single slotted flapped wing	H <sub>1.0</sub> +W <sub>3.0</sub> +E <sub>1.0</sub>	180	181
(c) Double slotted flapped wing	H <sub>1.0</sub> +W <sub>2.0</sub> +E <sub>1.0</sub>	179	181
(d) Boom-mounted stub wing	H <sub>1.0</sub> +W <sub>4.0</sub>	186	156
*Basic Code is K13.			

TABLE 1 (CONTINUED)

## OUTLINE OF WAKE INVESTIGATIONS

Description	Configuration Code*	Run No.	Base-line
2. Crown Fairings			
(a) Flat top behind shaft	K <sub>11</sub> +D <sub>1</sub>	140	138
(b) Round top behind shaft	K <sub>11</sub> +D <sub>2</sub>	141	138
(c) Extended flat top fairing	H <sub>1</sub> +D <sub>4</sub>	170	156
(d) Flat top + 16" cap, 4" gap	H <sub>1</sub> ·7·2+D <sub>4</sub>	171	170
(e) Forward fairing/nacelle fairing	P <sub>1</sub> ·0	152	156
3. Surface Devices			
(a) Vortex generators	K <sub>11</sub> +VG <sub>2.1</sub>	139	138
(b) Guidevane between nacelles	K <sub>11</sub> +FV <sub>1</sub>	142	138
(c) Longitudinal strakes	H <sub>1</sub> ·5·3+S <sub>4</sub>	155	156
(d) 14% porosity spoiler	K <sub>11</sub> +X <sub>1</sub>	143	138

\*Basic Code is K13 unless noted otherwise.

<p>TABLE 2</p> <p>LIST OF TEST RUNS</p> <p>BASIC INVESTIGATIONS OF THE HUB WAKE</p>										
RUN NO.	CONFIGURATION/CONDITION	VTUN KNOTS	RPM MR/TR	DISK LDG. psf	MODEL ANGLES		MR HT.		TAIL ROTOR	
					$\alpha^\circ$	$\psi^\circ$	$h/d$			
111	K <sub>11</sub> /15" Long. wake traverse at TR center line	80	1433/0	8	6.0	-2.0	$\infty$		Off	
112	" /9" Vert. wake traverse above TR center line	"	"	"	"	"	"		"	
113	" /2" Vert traverse through MR vortex	"	"	"	"	"	"		"	
114	" /8" Vert. traverse below TR center line	"	"	"	"	"	"		"	
115	" /13" Vert. traverse behind stabilizer	"	"	"	"	"	"		"	
116	" /Lateral traverse - left stabilizer	"	"	"	"	"	"		"	
117	" /116 continued	"	"	"	"	"	"		"	
118	" /116 continued	"	"	"	"	"	"		"	
119	" /Lateral traverse - right stabilizer	"	"	"	"	"	"		"	
121	K <sub>11</sub> +T <sub>2</sub> /Effect of tail rotor flow on wake	"	1433/4500	"	"	"	"		On	
135	K <sub>11</sub> /Wake in 900 fpm climb	"	"	"	-6.0	-4.5	"		Off	
136	" /Wake in 800 fpm descent	"	"	"	6.0	+2.0	"		"	



TABLE 2 (CONTINUED)  
LIST OF TEST RUNS  
EVALUATION OF WAKE-ALTERING DEVICES

RUN NO.	CONFIGURATION/CONDITION	V <sub>TUN</sub> KNOTS	RPM MR/TR	DISK LDG. psf	MODEL ANGLES		MR HT.	TAIL ROTOR
					$\alpha^\circ$	$\psi^\circ$		
137	K <sub>11</sub> -H <sub>1.0</sub> +H <sub>1.2</sub> /Effect of 7.6 inch diam. solid hub cap	80	1433/0	8	6	-3.8	$\infty$	Off
138	K <sub>11</sub> /Repeat of base run	"	"	"	"	"	"	"
139	K <sub>11</sub> +VG <sub>2.1</sub> /Effect of vortex generators on aft crown	"	"	"	"	"	"	"
140	K <sub>11</sub> +D <sub>1</sub> /Flat-topped "doghouse" fairing on aft crown	"	"	"	"	"	"	"
141	K <sub>11</sub> +D <sub>2</sub> /Rounded-top fairing	"	"	"	"	"	"	"
142	K <sub>11</sub> +FV <sub>1</sub> /Deflection vane on crown between nacelles	"	"	"	"	"	"	"
143	K <sub>11</sub> +X <sub>1</sub> /Variable porosity spoiler	"	"	"	"	"	"	"
149	K <sub>13</sub> +H <sub>1</sub> -N <sub>1</sub> /Effect of nacelles off also add stiff pitch arms (K <sub>13</sub> )	60	1075/0	4.5	"	"	"	"
150	K <sub>13</sub> +H <sub>1</sub> /60 knot baseline	"	"	"	"	"	"	"
151	K <sub>13</sub> +H <sub>1.3</sub> /16 inch diam. helmet fairing	"	"	"	"	"	"	"
152	K <sub>13</sub> +P <sub>1.0</sub> /Pylon and intake fairings	80	1433/0	8	"	"	"	"
153	K <sub>13</sub> +H <sub>1.2</sub> /Repeat 137 with K <sub>13</sub> pitch arms	"	"	"	"	"	"	"

TABLE 2 (CONTINUED)  
LIST OF TEST RUNS  
EVALUATION OF WAKE-ALTERING DEVICES

RUN NO.	CONFIGURATION/CONDITION	VTUN KNOTS	RPM MR/TR	DISK LDG. psf	MODEL ANGLES		MR HT. h/d	TAIL ROTOR
					$\alpha^\circ$	$\psi^\circ$		
154	K13+H1.5.2/10" open hub cap, 7" underbody, 1.25" gap	80	1433/0	8	6	-3.8	$\infty$	Off
155	K13+H1.5.2+S4/Same as 154 except strakes on aft crown	"	"	"	"	"	"	"
156	K13+H1.0/Baseline with K13, i.e., stiff pitch arms	"	"	"	"	"	"	"
158	K13-M+H1.0/Wake studies with blades off, hub not rotating	"	0/0	"	"	"	"	"
159	K13-M-H1.0/Wake studies with hub off	"	"	"	"	"	"	"
160	K13-M+H1.0/Same as 158 except hub is rotating	"	1433/0	"	"	"	"	"
161	K13-M+H1.5.2/Repeat of 154 without blades	"	0/0	"	"	"	"	"
162	K13-M+H1.5.3/Same as 161 except 4" gap	"	"	"	"	"	"	"
163	K13-M+H1.5.4/Same as 161 except 2" gap	"	"	"	"	"	"	"
164	K13-M+H1.5.1/Same as 161 except 0.5" gap	"	"	"	"	"	"	"
165	K13-M+H1.0.1/10" open hub cap, no underbody, same cap vert. position as Run 154	"	"	"	"	"	"	"
166	K13-M+H1.0.2/Same as 165 with cap lowered by 0.5"	"	"	"	"	"	"	"

TABLE 2 (CONTINUED)  
LIST OF TEST RUNS  
EVALUATION OF WAKE-ALTERING DEVICES

RUN NO.	CONFIGURATION/CONDITION	VTUN KNOTS	RPM MR/TR	DISK LDG. psf	MODEL ANGLES		MR HT. h/d	TAIL ROTOR
					$\alpha^\circ$	$\psi^\circ$		
167	K <sub>13</sub> -M+H <sub>1.7.1/16"</sub> open cap, no underbody, 2" gap	80	0/0	8	6	-3.8	$\infty$	Off
168	K <sub>13</sub> +H <sub>1.7.1/Blades on, same cap config. as 167</sub>	"	1433/0	"	"	"	"	"
169	K <sub>13</sub> +H <sub>1.7.2/16"</sub> open cap, no underbody, 4" gap	"	"	"	"	"	"	"
170	K <sub>13</sub> +H <sub>1.0</sub> +D <sub>4.0</sub> /Extended flat top fairing on aft crown	"	"	"	"	"	"	"
171	K <sub>13</sub> +H <sub>1.7.2</sub> +D <sub>4.0</sub> /Same fairing as 170, same cap as 169	"	"	"	"	"	"	"
172	K <sub>13</sub> +H <sub>1.0</sub> +E <sub>1.0</sub> (0psi)/Basic air ejector zero blowing baseline	"	"	"	"	"	"	"
173	K <sub>13</sub> +H <sub>1.0</sub> +E <sub>1.0</sub> (40 psi)/Same as 172 with 40 psi supply	"	"	"	"	"	"	"
174	K <sub>13</sub> +H <sub>1.0</sub> +E <sub>1.0</sub> (150 psi)/Same as 172 with 150 psi supply	"	"	"	"	"	"	"
175	K <sub>13</sub> +H <sub>1.0</sub> +E <sub>2.5.1</sub> (40 psi)/Ejector with wide chord shroud at 40 psi	"	"	"	"	"	"	"
176	K <sub>13</sub> +H <sub>1.0</sub> +E <sub>2.5.1</sub> (150 psi)/Same as 174 with 150 psi supply	"	"	"	"	"	"	"
177	K <sub>13</sub> +H <sub>1.5</sub> +E <sub>2.5.1</sub> (150 psi)/Same as 176 with 10" cap like 163	"	"	"	"	"	"	"
178	K <sub>13</sub> +H <sub>1.0</sub> +W <sub>1.0</sub> +E <sub>1.1</sub> (0 psi)/Nacelle mounted wing	"	"	"	"	"	"	"



TABLE 2 (CONTINUED)  
LIST OF TEST RUNS  
EVALUATION OF WAKE-ALTERING DEVICES

RUN NO.	CONFIGURATION/CONDITION	VTUN KNOTS	RPM MR/TR	DISK LDG. psf	MODEL ANGLES		MR HT. h/d	TAIL ROTOR
					$\alpha^\circ$	$\psi^\circ$		
179	K <sub>13</sub> +H <sub>1.0</sub> +W <sub>2.0</sub> +E <sub>1.0</sub> (0 psi)/Double slotted flapped wing	80	1433/0	8	6	-3.8	$\infty$	Off
180	K <sub>13</sub> +H <sub>1.0</sub> +W <sub>3.0</sub> +E <sub>1.0</sub> (0 psi)/Single slotted flapped wing	"	"	"	"	"	"	"
181	K <sub>13</sub> +H <sub>1.0</sub> +E <sub>1.2</sub> (0 psi)/Baseline with ejector tube moved aft	"	"	"	"	"	"	"
182	K <sub>13</sub> +H <sub>1.9.0</sub> +E <sub>1.2</sub> (0 psi)/Standard 10" frisbee	"	"	"	"	"	"	"
183	K <sub>13</sub> +H <sub>1.9.1</sub> +E <sub>1.2</sub> (0 psi)/16" fabricated frisbee	"	"	"	"	"	"	"
184	K <sub>13</sub> +H <sub>1.0</sub> +E <sub>3.5.2</sub> (40 psi)/Wide chord with lip at 40 psi	"	"	"	"	"	"	"
185	K <sub>13</sub> +H <sub>1.0</sub> +E <sub>3.5.2</sub> (150 psi)/Same as 184 with 150 psi air	"	"	"	"	"	"	"
186	K <sub>13</sub> +H <sub>1.0</sub> +W <sub>4.0</sub> /Boom mounted stub wing	"	"	"	"	"	"	"
187	K <sub>13</sub> +H <sub>1.0</sub> +E <sub>3.5.4</sub> (150 psi)/Like 185 with modified shroud	"	"	"	"	"	"	"
188	K <sub>13</sub> +H <sub>1.0</sub> +I <sub>1</sub> +E <sub>1.0</sub> (0 psi)/Baseline with I <sub>1</sub> instr. ring	"	"	"	"	"	"	"
189	K <sub>13</sub> +H <sub>1.8.1</sub> +I <sub>1</sub> +E <sub>1.0</sub> (0 psi)/Solid cap, 10" diam. 3.25" height	"	"	"	"	"	"	"
190	K <sub>13</sub> +H <sub>1.8.2</sub> +I <sub>1</sub> +E <sub>1.0</sub> (0 psi)/Same as 190 except + 4.12" height	"	"	"	"	"	"	"

TABLE 2 (CONTINUED)

## LIST OF TEST RUNS

## EVALUATION OF WAKE-ALTERING DEVICES

RUN NO.	CONFIGURATION/CONDITION	VTUN KNOTS	RPM MR/TR	DISK LDG. psf	MODEL ANGLES		MR HT. h/d	TAIL ROTOR
					$\alpha^\circ$	$\psi^\circ$		
191	K13+H1.0.2+I1+E1.0 (0 psi)/10" cap, no underbody, 1.87" gap	80	1433/0	8	6	-3.8	$\infty$	Off
193	K13+H1.0.2+I1+E1.0 (0 psi)/10" cap, no underbody, 1.25" gap	"	"	"	"	"	"	"
194	K13+H1.11.1+I2+E1.0 (0 psi)/7.6" cap, underbody, 1.25" gap	"	"	"	"	"	"	"
195	K13+H1.11.1+I2+E1.0 (20 psi)/Same as 194 with 20 psi air	"	"	"	"	"	"	"
196	K13+H1.11.1+I2+E1.0 (40 psi)/Same as 194 with 40 psi air	"	"	"	"	"	"	"
197	K13+H1.11.1+I2+E1.0 (150 psi)/Same as 194 with 150 psi air	"	"	"	"	"	"	"
198	K13+H1.11.1+I2+E4.0 (0 psi)/Same as 194 except blowing tube 2" aft	"	"	"	"	"	"	"
199	K13+H1.11.1+I2+E4.0 (40 psi)/Same as 198 with 40 psi air	"	"	"	"	"	"	"
200	K13+H1.11.1+I2+E4.0 (150 psi)/Same as 198 with 150 psi air	"	"	"	"	"	"	"
201	K13+H1.11.2+I2+E4.0 (150 psi)/Same as 200 except center support cap	"	"	"	"	"	"	"
202	K13+H1.11.2+I2/Baseline with I2 and no blowing tube	"	"	"	"	"	"	"
203	K13+H1.0+E5.0 (0 psi)/Bifurcated air duct baseline	"	"	"	"	"	"	"

**TABLE 2 (CONTINUED)**  
**LIST OF TEST RUNS**  
**EVALUATION OF WAKE-ALTERING DEVICES**

[illegible]



TABLE 3					
INDEX TO RAKE POSITIONS					
RUN NUMBER	TEST POINT	WATER LINE	MODEL STATION	BUTT LINE	LOCATION FIGURE
111	20	53.5	103.1	-7.25	1
	21	"	"	"	
	22	"	105.0	"	
	24	"	107.0	"	
	26	"	109.0	"	
	28	"	111.0	"	
	30	"	112.9	"	
	32	"	114.9	"	
	34	"	116.9	"	
	36	"	118.9	"	
112	2	48.9	107.3	-7.25	1
	4	50.8	"	"	
	6	52.7	103.3	"	
	8	54.5	"	"	
	10	56.2	"	"	
	12	57.2	"	"	
113	2	51.7	103.3	-3.25	1
	4	52.3	"	"	
	6	52.8	"	"	
	8	53.3	"	"	
	10	53.9	"	"	
	11	53.3	"	"	
114	2	44.5	103.0	-3.25	1
	4	46.4	"	"	
	6	48.2	"	"	
	8	50.0	"	"	
	10	51.9	"	"	
115	3	52.9	124.7	-3.25	1
	4	52.0	"	"	
	6	50.0	"	"	
	9	48.0	"	"	
	10	46.0	"	"	
	12	44.1	"	"	
	14	42.1	"	"	
	16	53.0	"	"	
	18	54.0	"	"	
	20	55.0	"	"	

TABLE 3 (CONTINUED)					
INDEX TO RAKE POSITIONS					
RUN NUMBER	TEST POINT	WATER LINE	MODEL STATION	BUTT LINE	LOCATION FIGURE
116	7	36.9	100.5	-17.5	1
117	2 4 6 8 10	37.6 " 37.3 " "	100.5 " 99.6 " "	-16.0 -14.0 -12.0 -10.0 - 8.0	1
118	2	37.6	100.5	- 6.0	1
119	2 5 8 9 14 16 20 25	37.3 " " " " " 51.5 52.3	99.6 " " " " " 102.5 101.7	+ 6.0 8 10 " 14 16 17.5 -17.5	1
121	3 4 6 8 10	62.9 53.5 50.1 46.0 42.1	129.0 " " " "	+ 5.7 " " " "	2
135	2 4 6 8 10 12 14	56.9 54.5 52.5 50.5 48.5 46.5 44.5	106.3 " " " " " "	- 5.7 " " " " " "	3
136	2 4 6 8 10 12 14 17 18 19	56.5 54.5 52.5 50.6 48.5 46.5 44.5 37.1 39.0 41.0	104.0 " " " " " " " " "	- 8.0 " " " " " " " " "	4

TABLE 3 (CONTINUED)					
INDEX TO RAKE POSITIONS					
RUN NUMBER	TEST POINT	WATER LINE	MODEL STATION	BUTT LINE	LOCATION FIGURE
137	3	38.7	98.4	- 8.0	5
	5	39.9	"	"	
	7	42.0	100.5	"	
	9	44.0	"	"	
	11	46.0	103.6	"	
	13	48.0	"	"	
	15	50.0	"	"	
	17	52.0	"	"	
	19	54.0	"	"	
138-41, 143	2	38.8	98.4	- 8.0	5
	3	40.0	"	"	
	4	42.0	100.5	"	
	5	44.0	"	"	
	6	46.0	103.6	"	
	7	48.0	"	"	
	8	50.0	"	"	
	9	52.0	"	"	
	10	54.0	"	"	
142	7	37.8	98.4	- 8.0	5
	8	"	"	"	
	9	40.2	"	"	
	10	42.0	100.5	"	
	11	44.0	"	"	
	12	46.0	103.6	"	
	13	48.0	"	"	
	14	50.0	"	"	
	15	52.0	"	"	
	16	54.0	"	"	
	17	56.8	"	"	



TABLE 3 (CONTINUED)					
INDEX TO RAKE POSITIONS					
RUN NUMBER	TEST POINT	WATER LINE	MODEL STATION	BUTT LINE	LOCATION FIGURE
149-151	2	38.8	98.5	- 8.0	5
	3	40.0	"	"	
	4	42.0	100.6	"	
	5	44.0	"	"	
	6	46.0	103.5	"	
	7	48.0	"	"	
	8	50.0	"	"	
	9	52.0	"	"	
	10	54.0	"	"	
152-6, 158	2	42.9	97.9	0.0	6
161-4, 166	3	44.9	"	"	
167, 169-71	4	46.9	100.6	"	
175, 177-9	5	48.9	"	"	
180, 182, 184	6	50.9	104.6	"	
186-8, 190	7	52.9	"	"	
191, 193, 194	8	54.9	"	"	
196, 198, 201	9	56.9	"	"	
204, 207, 208					
211					
159	1	54.9	104.6	0.0	6
	2	52.9	"	"	
	3	50.7	"	"	
	4	48.6	100.6	"	
	5	46.7	"	"	
160, 203	5	42.9	97.9	0.0	6
	6	44.9	"	"	
	7	46.9	100.6	"	
	8	48.9	"	"	
	9	50.9	104.6	"	
	10	52.9	"	"	
	11	54.9	"	"	
165	3	44.9	97.9	0.0	6
	4	42.9	"	"	
	5	46.9	100.6	"	
	6	48.9	"	"	
	7	50.9	104.6	"	
	8	52.9	"	"	

**TABLE 3 (CONTINUED)**  
**INDEX TO RAKE POSITIONS**

<b>RUN NUMBER</b>	<b>TEST POINT</b>	<b>WATER LINE</b>	<b>MODEL STATION</b>	<b>BUTT LINE</b>	<b>LOCATION FIGURE</b>
168, 183	4	42.9	97.9	0.0	6
	5	44.9	"	"	
	6	46.9	100.6	"	
	7	48.9	"	"	
	8	50.9	104.6	"	
	9	52.9	"	"	
	10	54.9	"	"	
172	3	42.9	97.9	0.0	6
	4	44.9	"	"	
	6	44.9	"	"	
	7	46.9	100.6	"	
	8	48.9	"	"	
	9	50.9	104.6	"	
	10	52.9	"	"	
173,174,176 185,195,197 199,200,205 210	1	42.9	97.9	0.0	6
	2	44.9	"	"	
	3	46.9	100.6	"	
	4	48.9	"	"	
	5	50.9	104.6	"	
	6	52.9	"	"	
	7	54.9	"	"	
181	2	42.9	97.9	0.0	6
	3	44.9	"	"	
	4	46.9	100.6	"	
	5	48.9	"	"	
	6	50.9	104.6	"	
	7	52.9	"	"	
	9	54.9	"	"	
	10	"	"	"	
	11	"	"	"	
	12	"	"	"	
	13	42.9	97.9	"	

TABLE 3 (CONTINUED)

INDEX TO RAKE POSITIONS

[illegible]



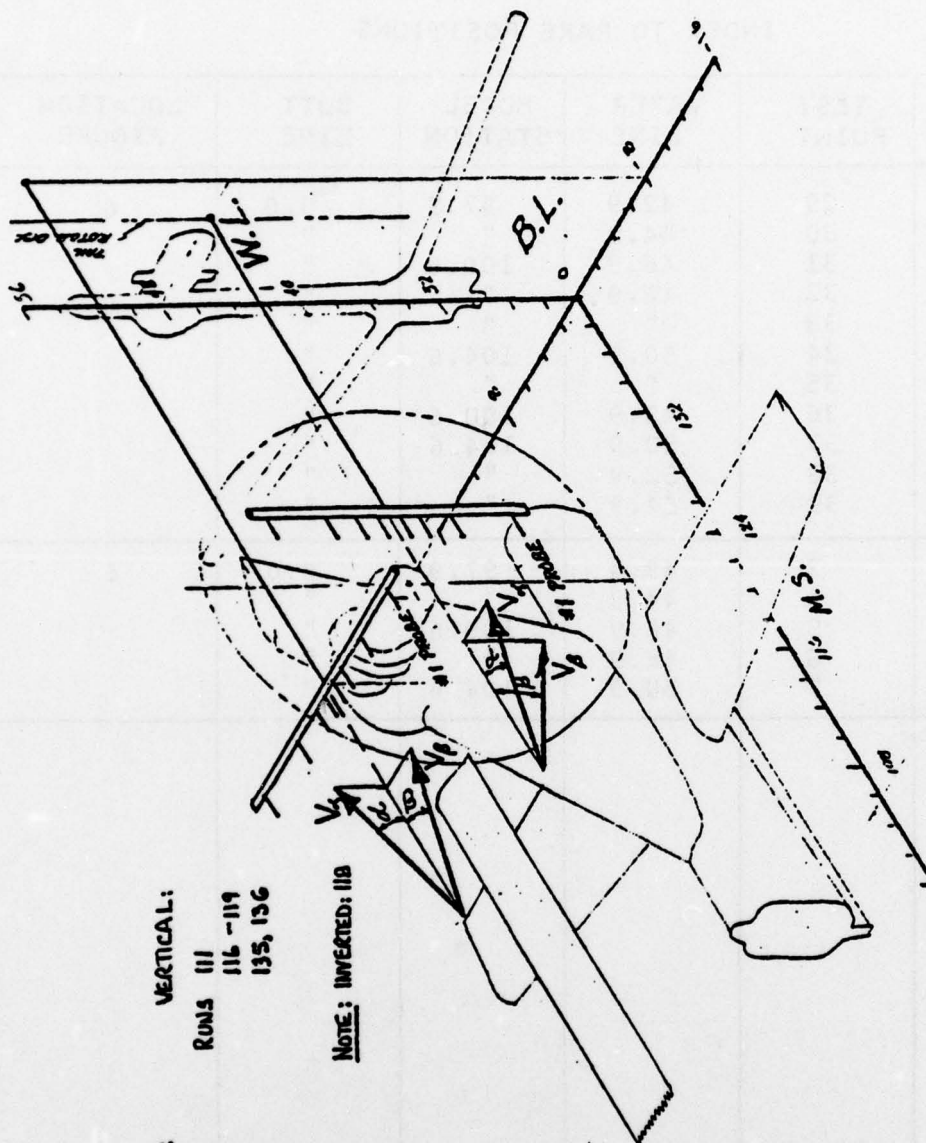


FIGURE 1 - RAKE ORIENTATION DIAGRAM

RUN 121

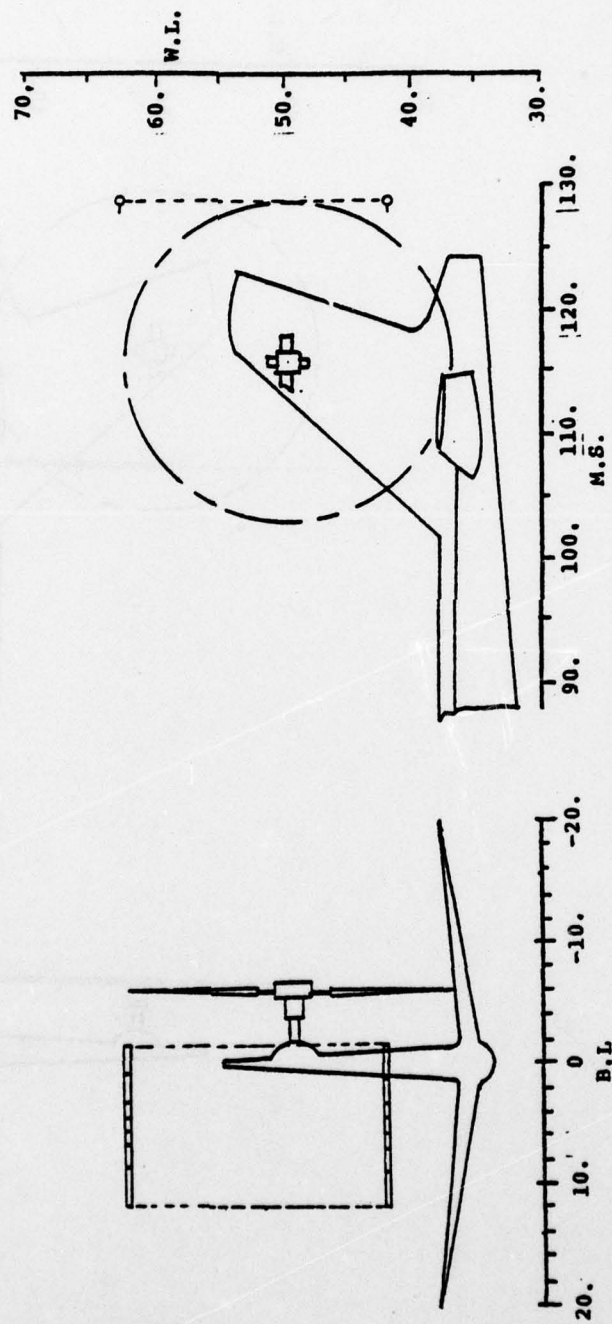


FIGURE 2 -HOT FILM RAKE LOCATIONS

RUN 135

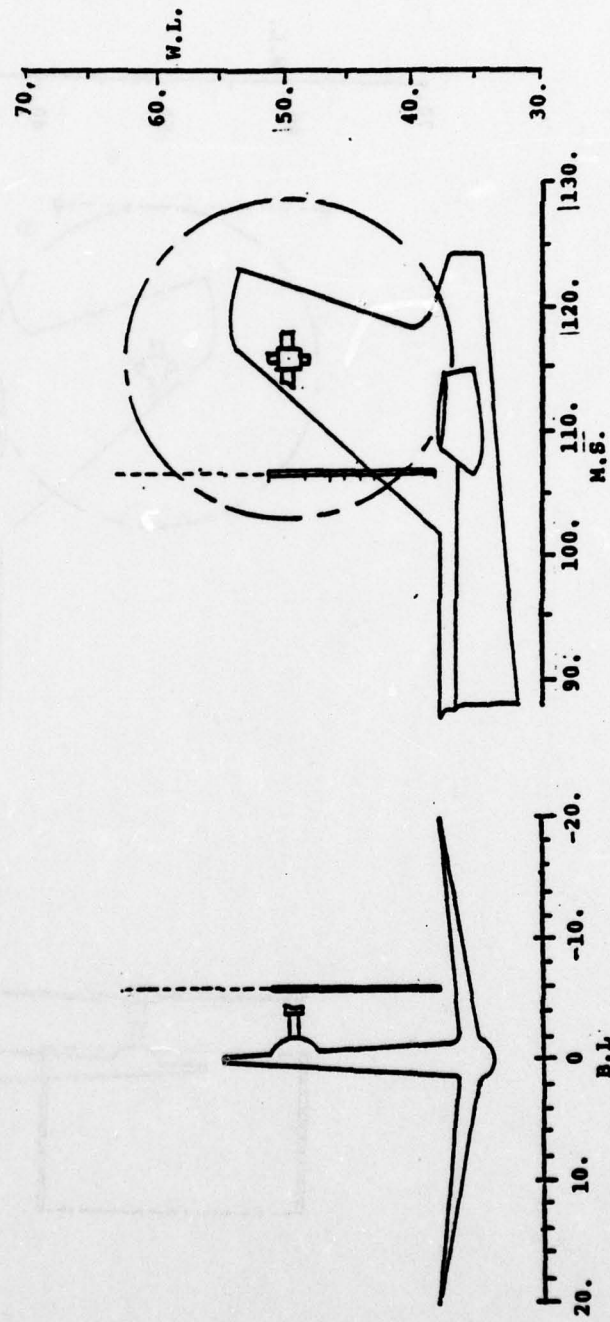


FIGURE 3 -HOT FILM RAKE LOCATIONS



RUN 136

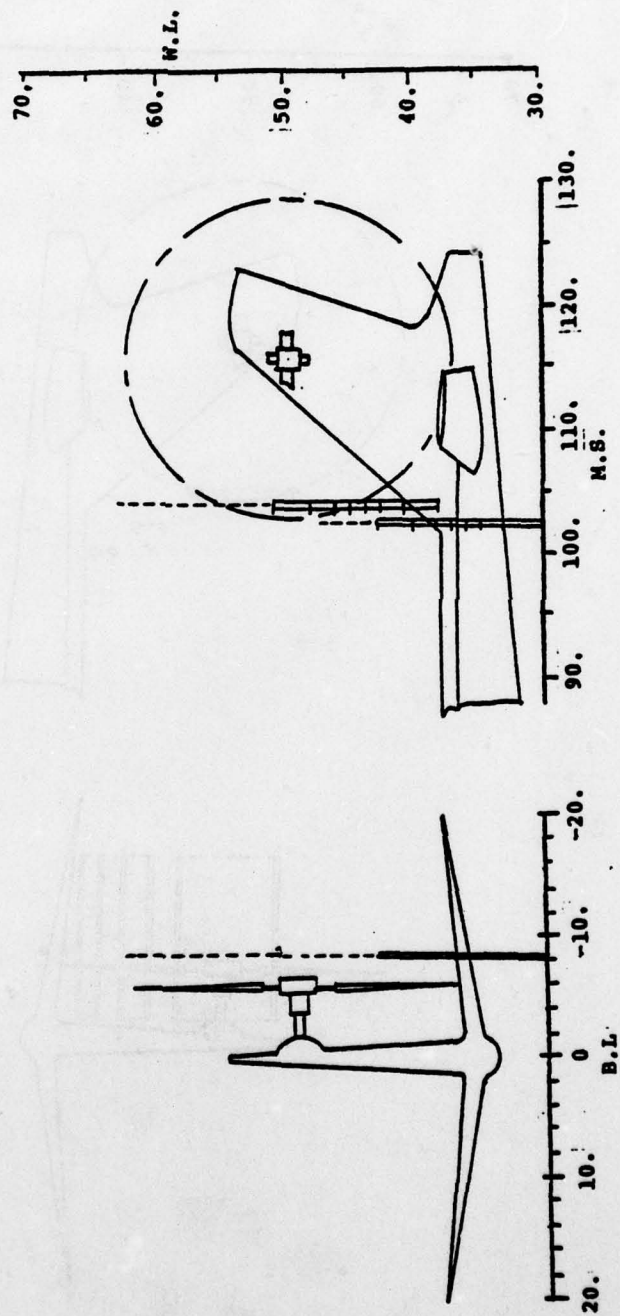


FIGURE 4 -HOT FILM RAKE LOCATIONS

RUN 137, 138, 139, 140, 141, 142,  
143, 148, 149, 150, 151

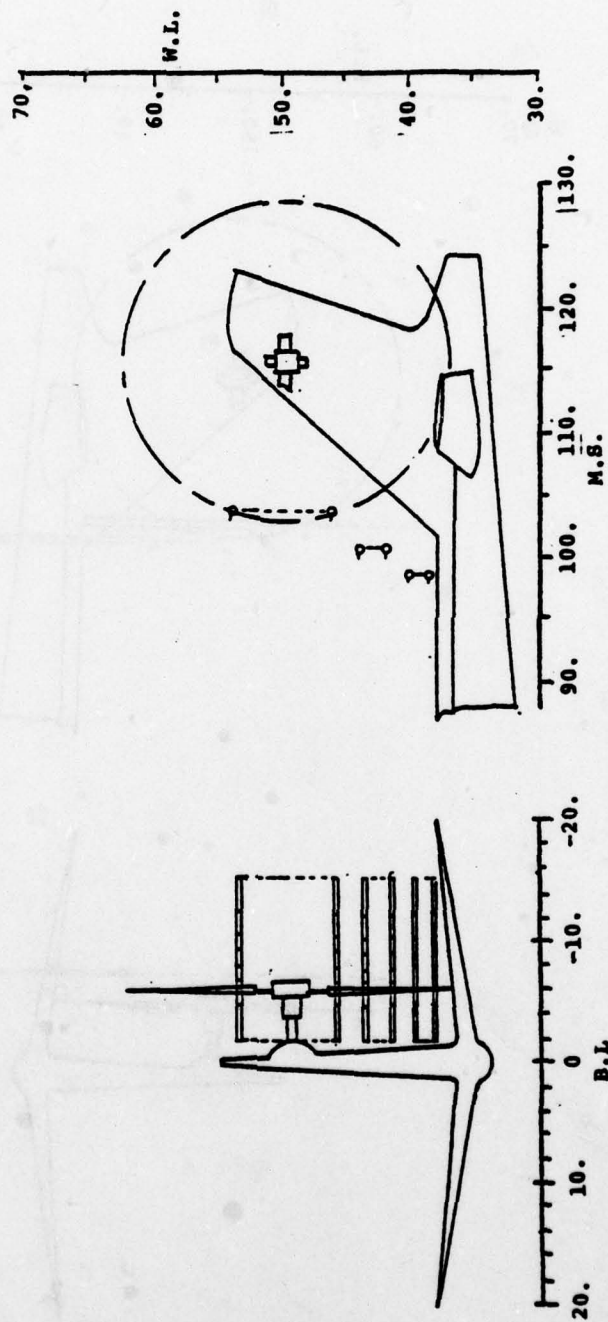


FIGURE 5 -HOT FILM RAKE LOCATIONS

RUN 152-156, 158-211

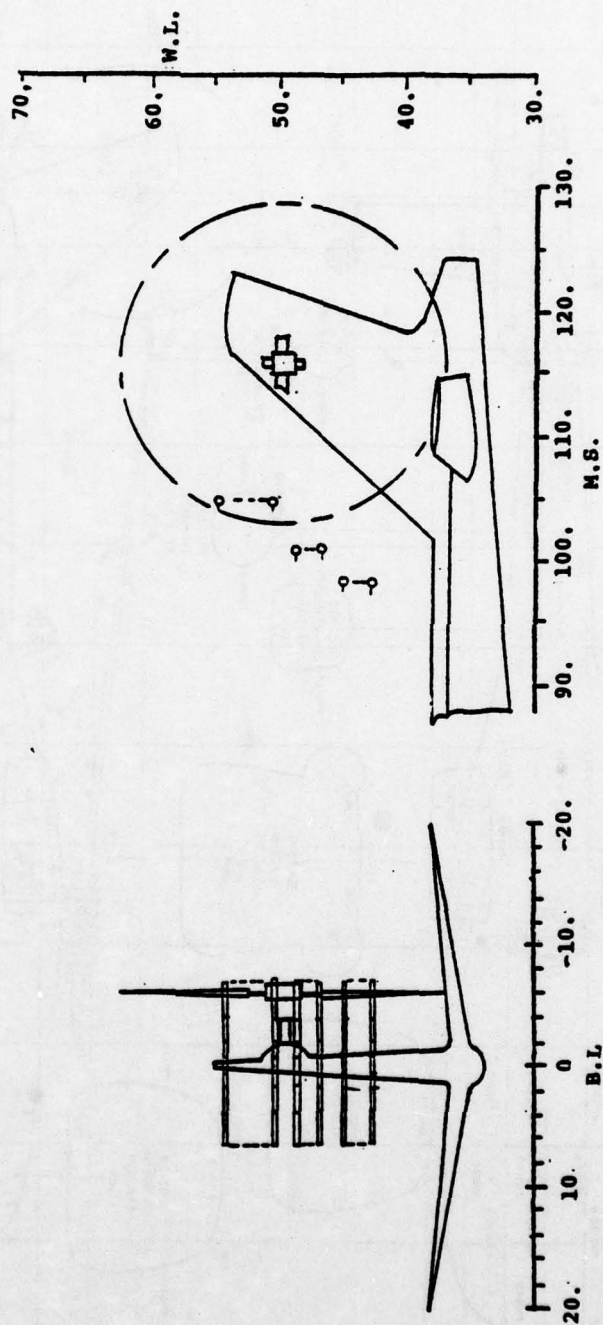


FIGURE 6 -HOT FILM RAKE LOCATIONS



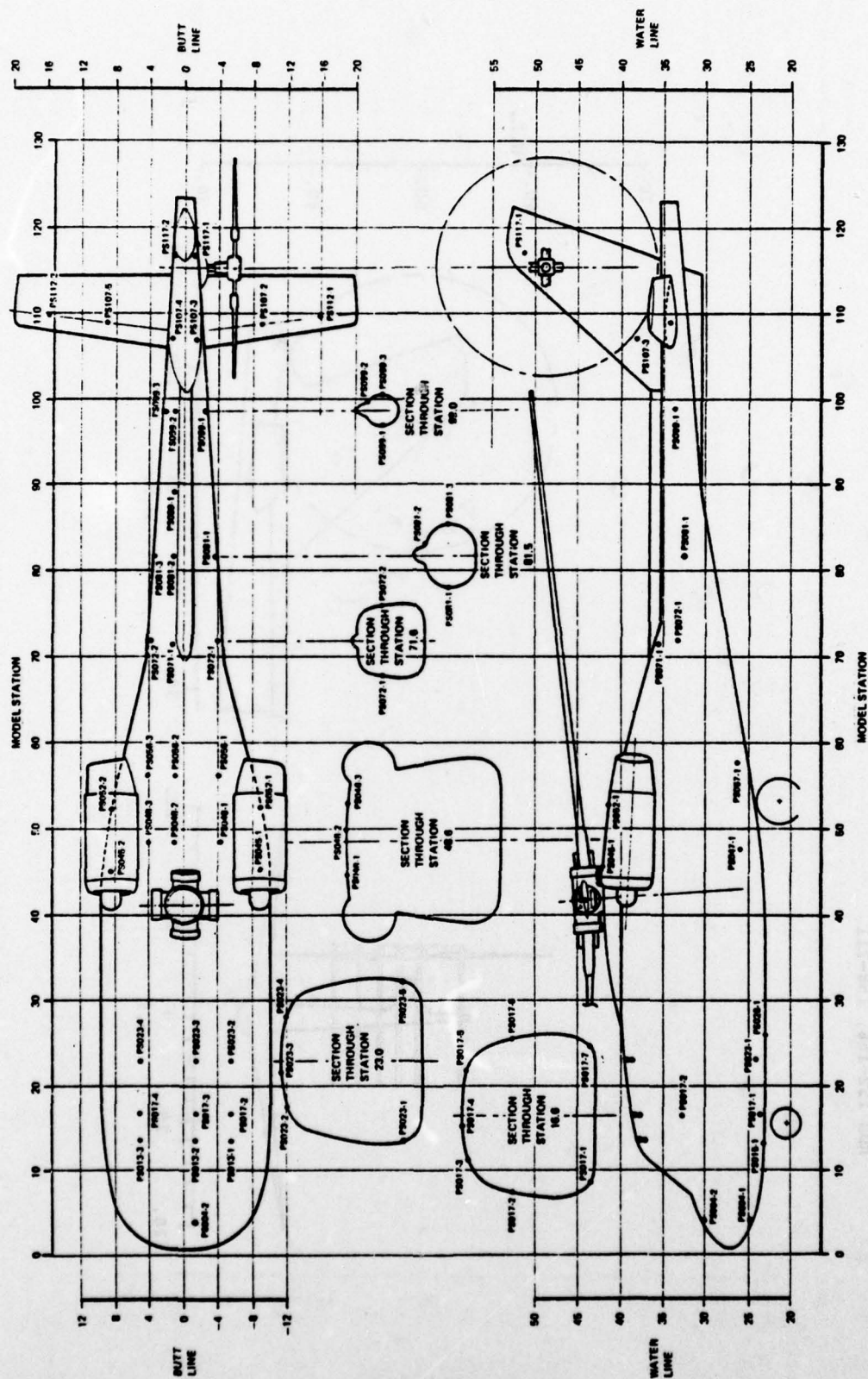


FIGURE 7 -1/4.85 SCALE MODEL GEOMETRY AND  
SURFACE PRESSURE TRANSDUCER LOCATIONS

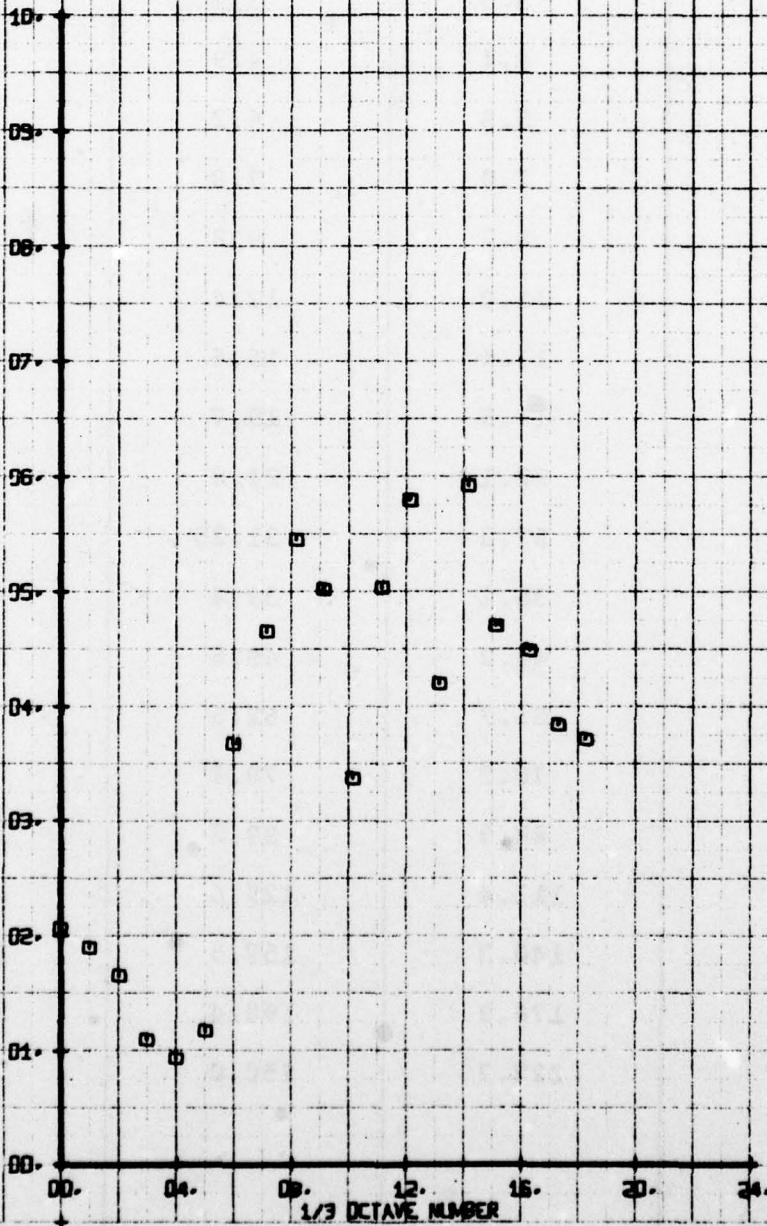
TABLE 4  
1/3 OCTAVE BAND IDENTIFICATION

BAND NUMBER	BAND WIDTH - Hz		
	MINIMUM	CENTER	MAXIMUM
0	3.5	3.4	4.4
1	4.4	4.9	5.5
2	5.5	6.2	7.0
3	7.0	7.8	8.7
4	8.7	9.8	11.0
5	11.0	12.4	13.9
6	13.4	15.6	17.5
7	17.5	19.7	22.1
8	22.1	24.8	27.8
9	27.8	31.25	35.1
10	35.1	39.4	44.2
11	44.2	49.6	55.7
12	55.7	62.5	70.2
13	70.2	78.7	88.9
14	88.9	99.2	111.4
15	111.4	125.0	140.3
16	140.3	157.5	176.8
17	176.8	198.4	222.7
18	222.7	250.0	280.6

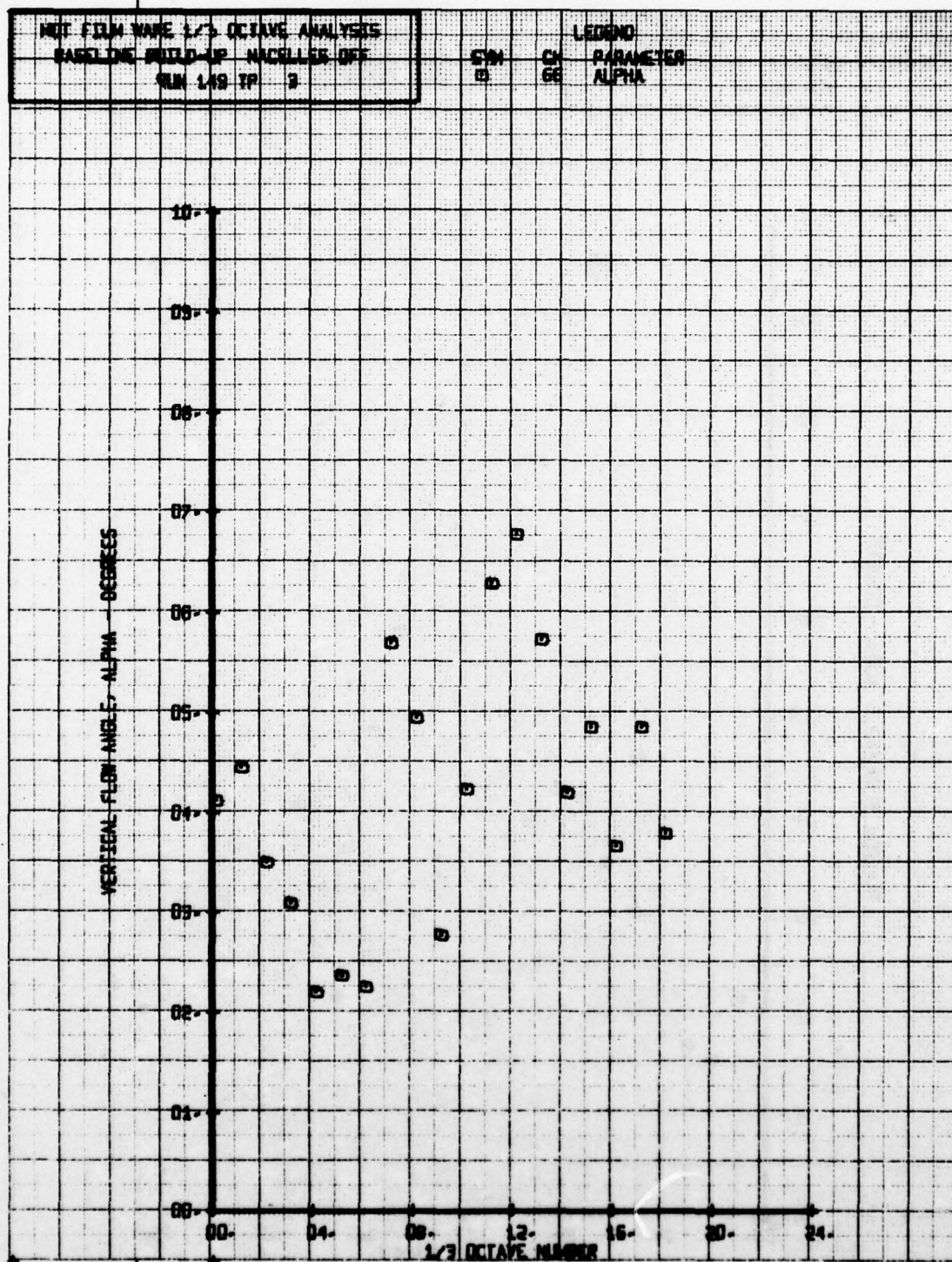
HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE BUILD-UP NACELLES OFF  
 RUN 148 TP 2

SYN CH  
 0 66  
 LEGEND  
 PARAMETER  
 ALPHA

VERTICAL FLOW ANGLE, ALPHA - DEGREES

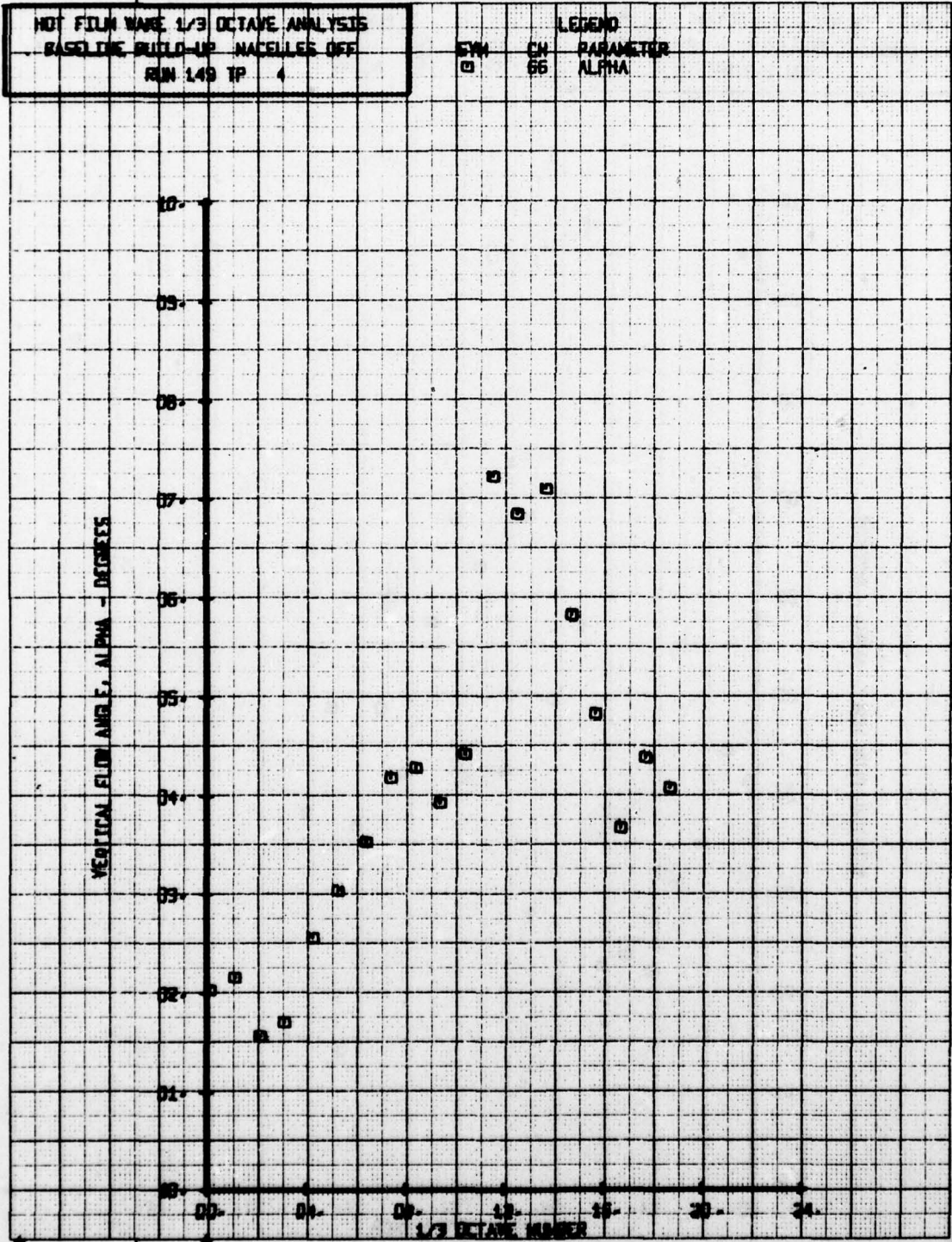






HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE BUILD-UP NACELLES OFF  
 RUN 149 TP 4

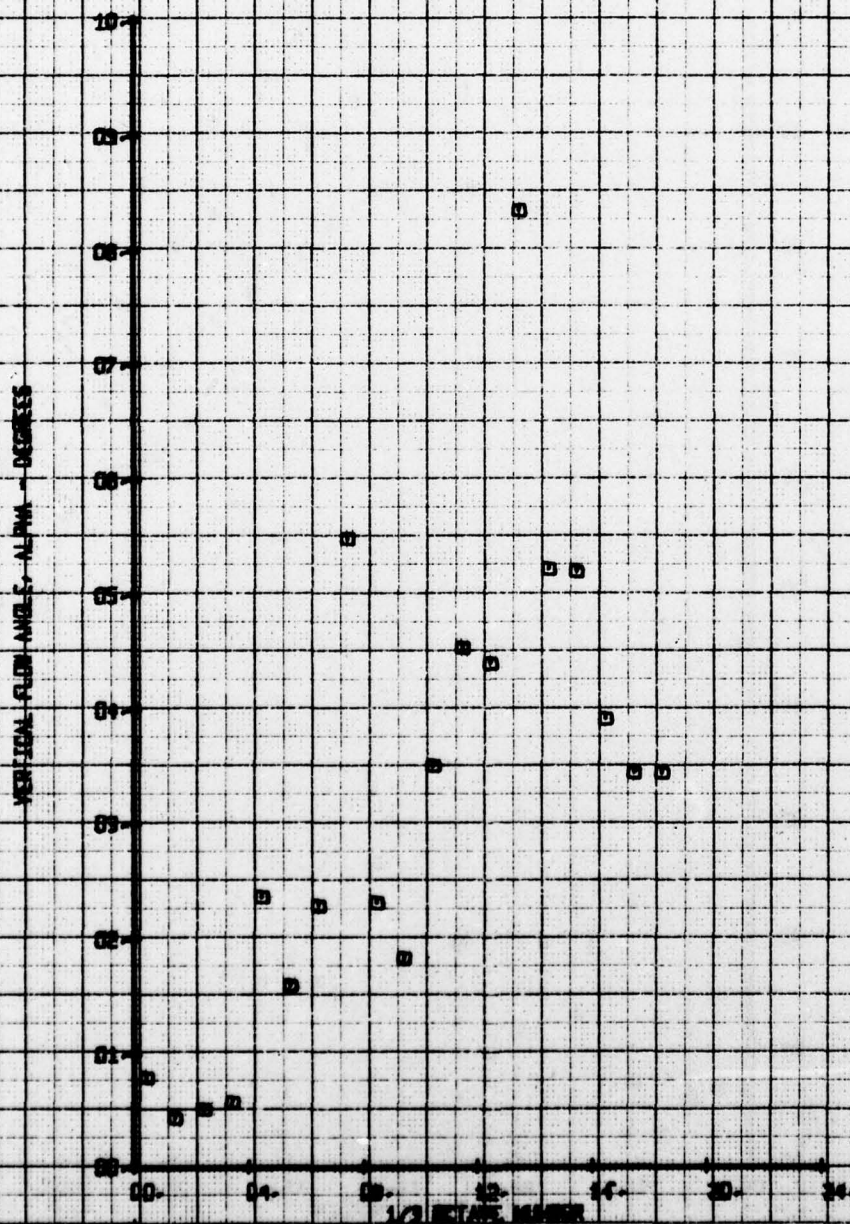
SYM CH PARAMETER  
 □ 66 ALPHA



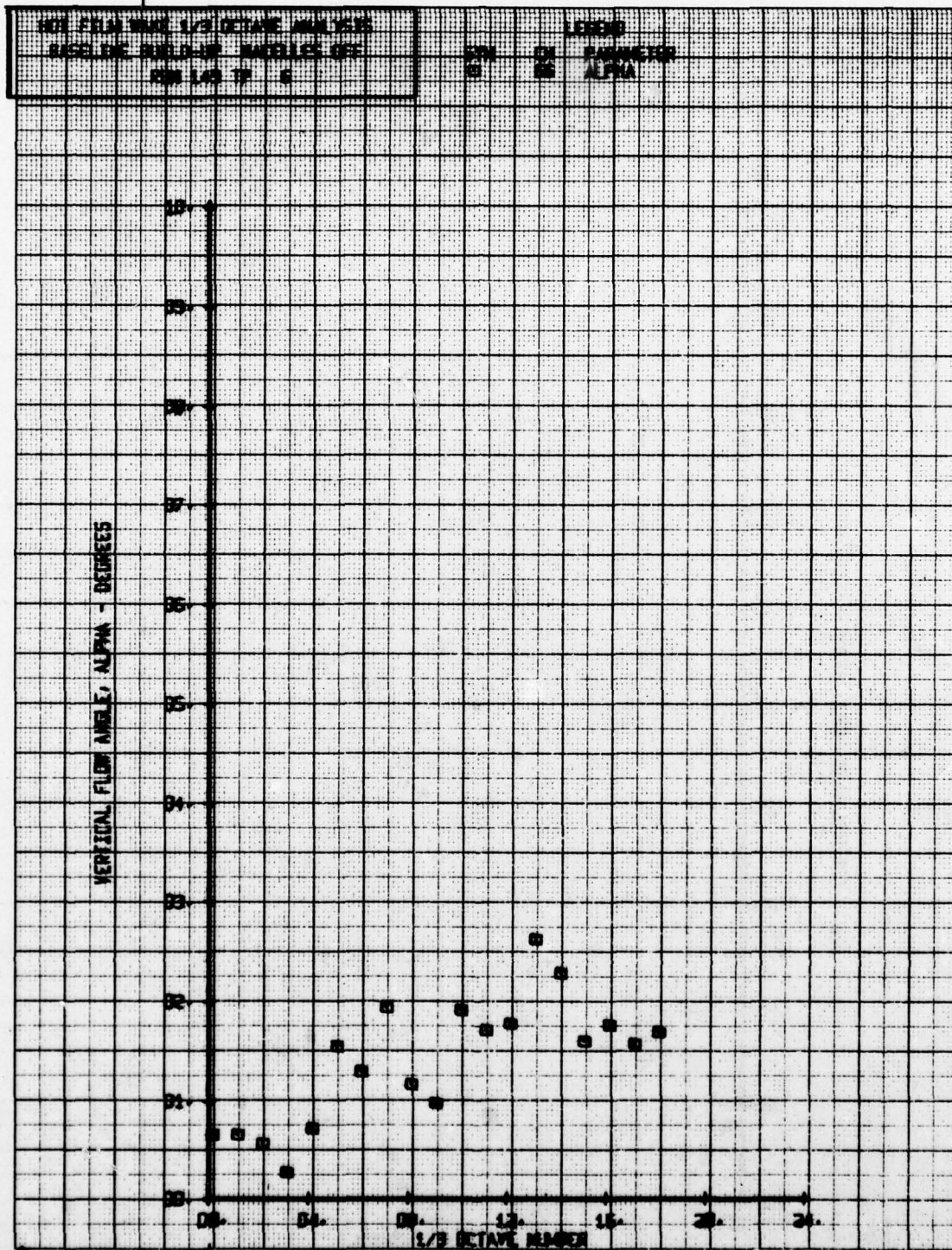


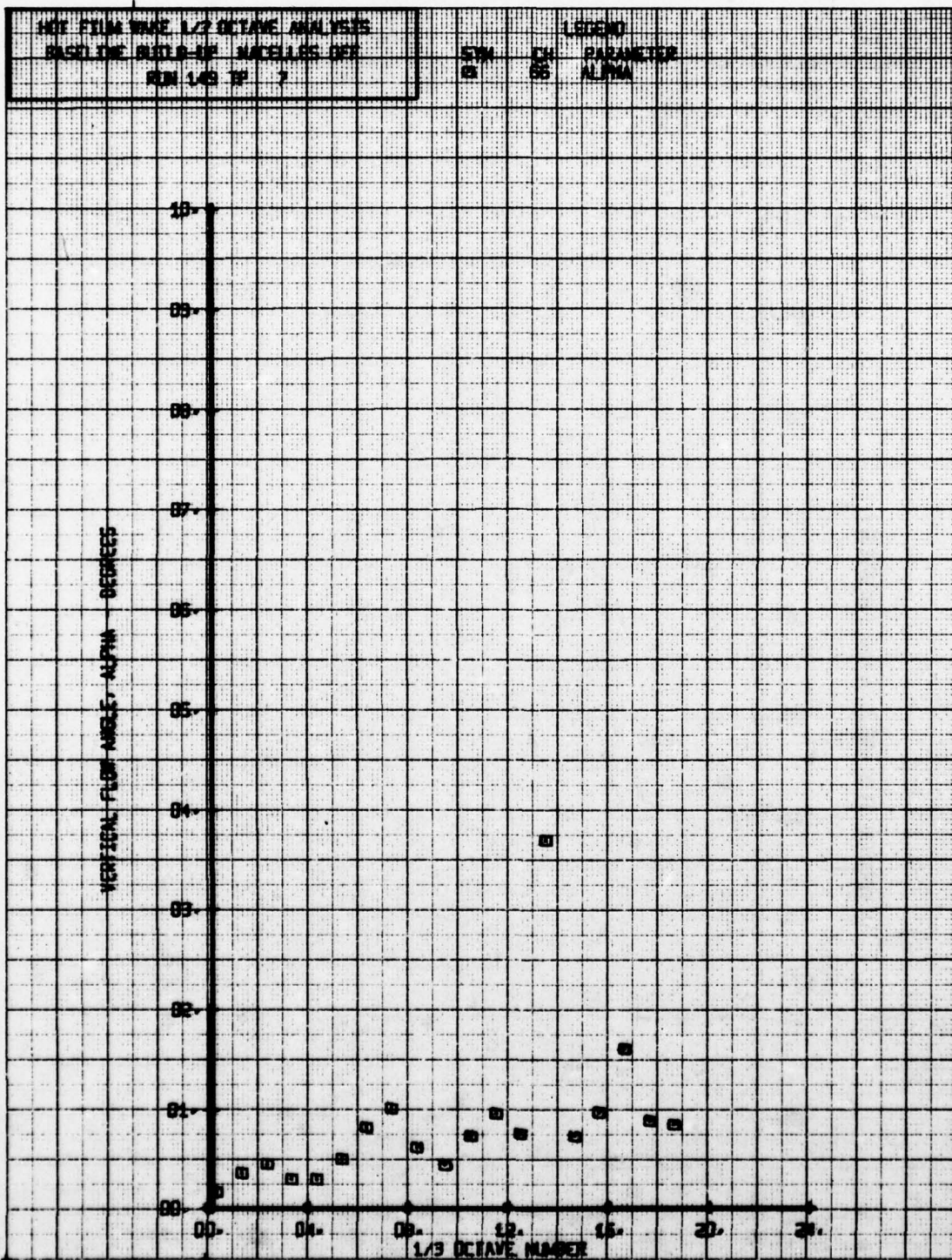
HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 SANDLINE BUILD-UP NACELLES OFF  
 RUN 149 TP 5

SYN CH  
 0 66  
 LEGEND  
 PARAMETER  
 ALPHA

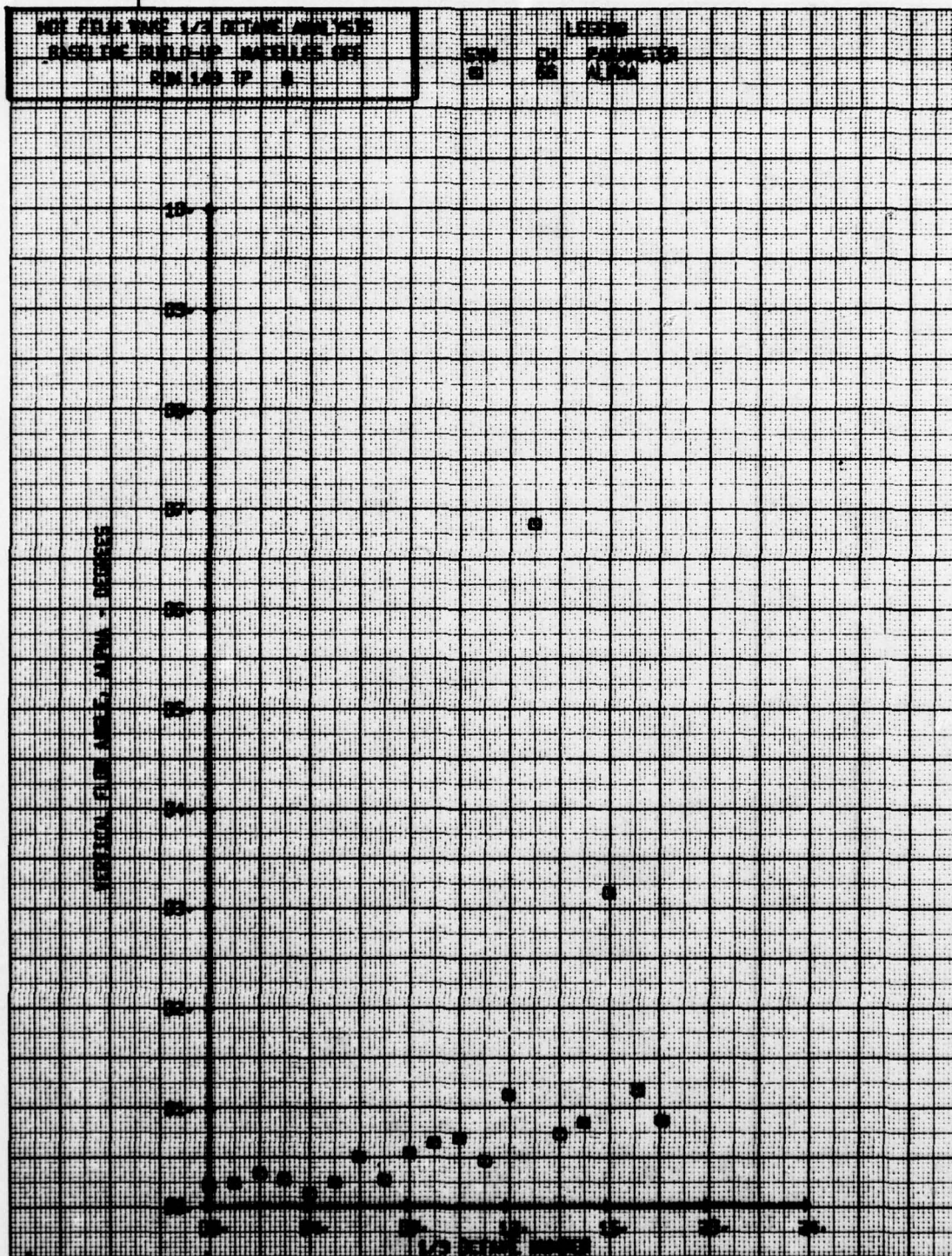








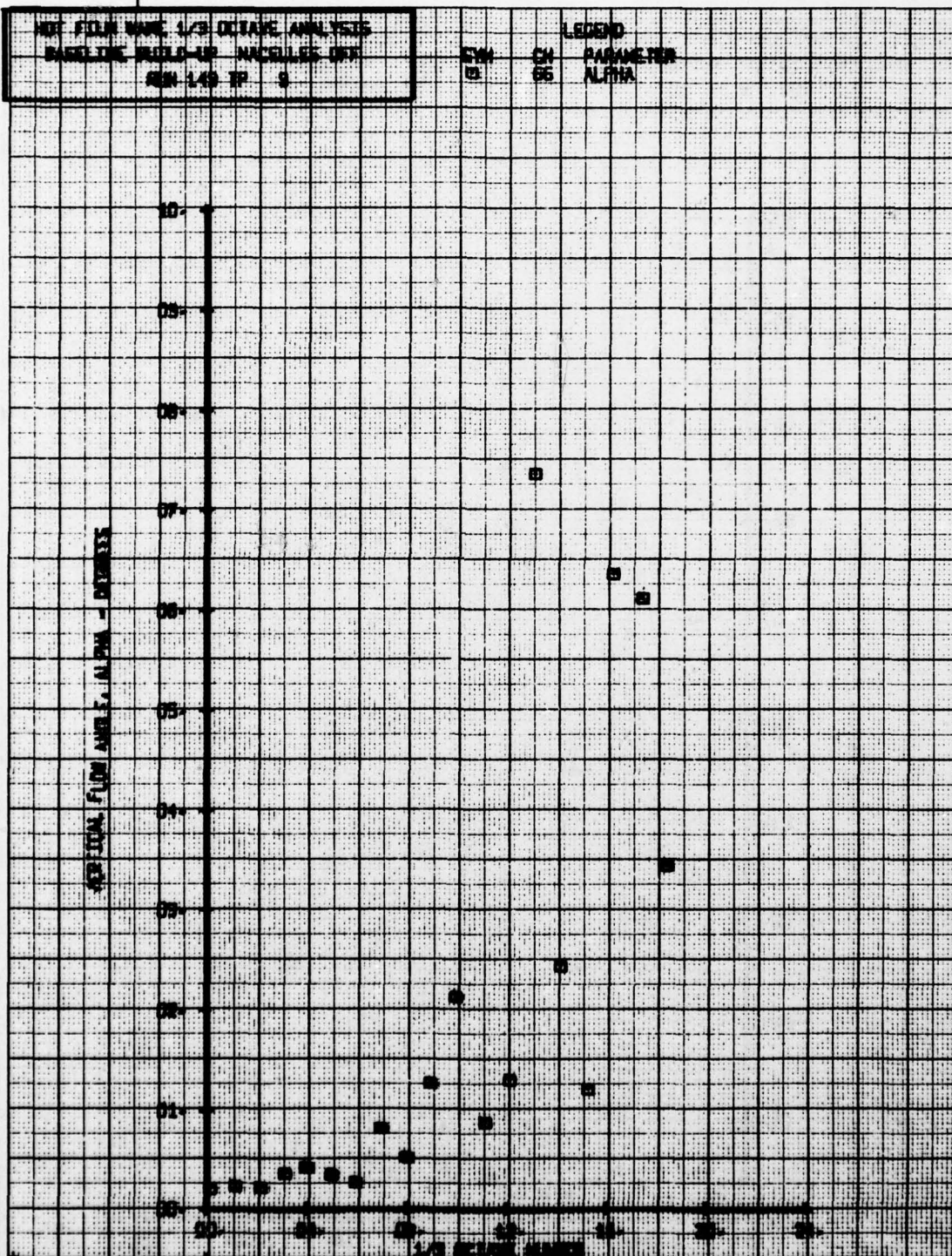


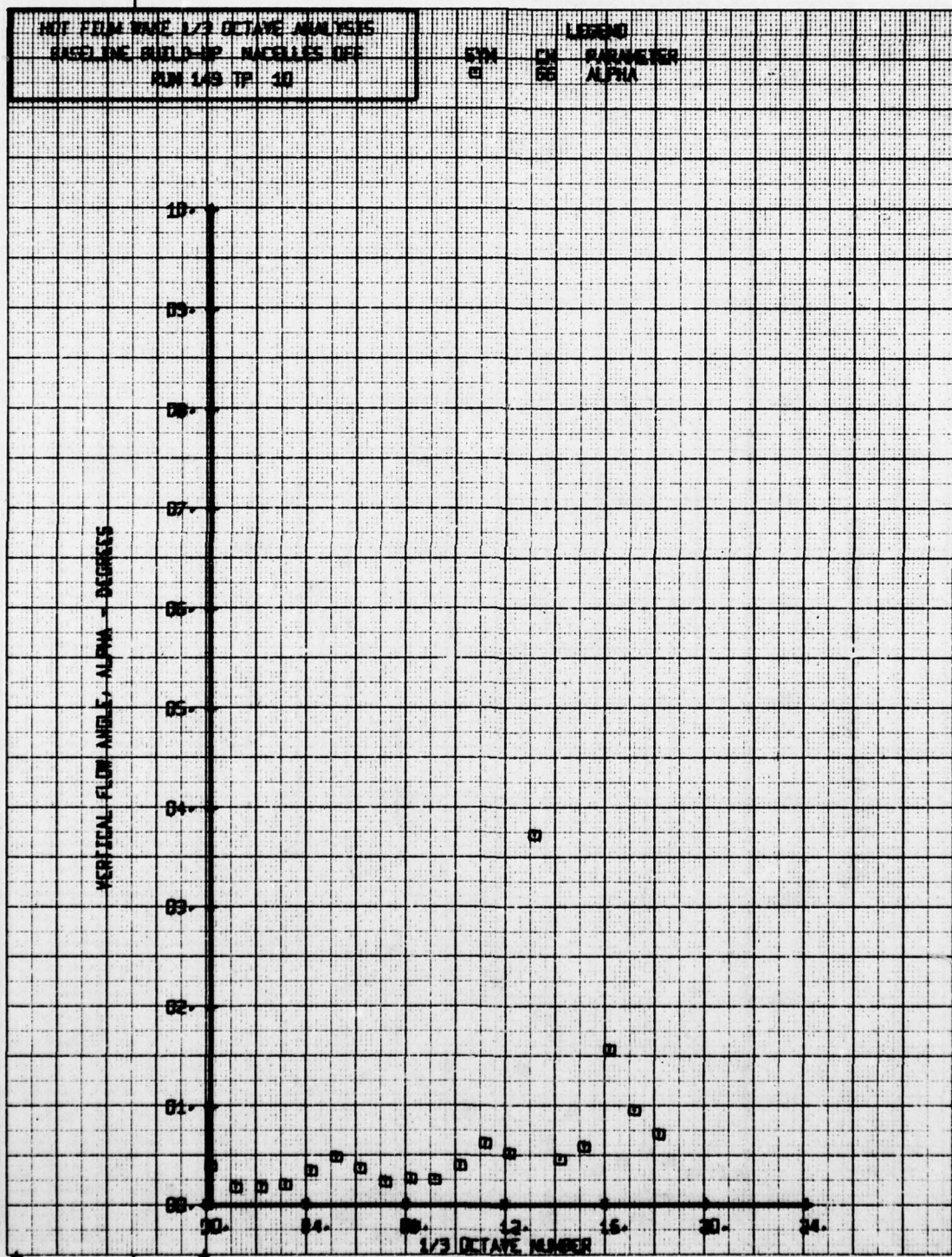




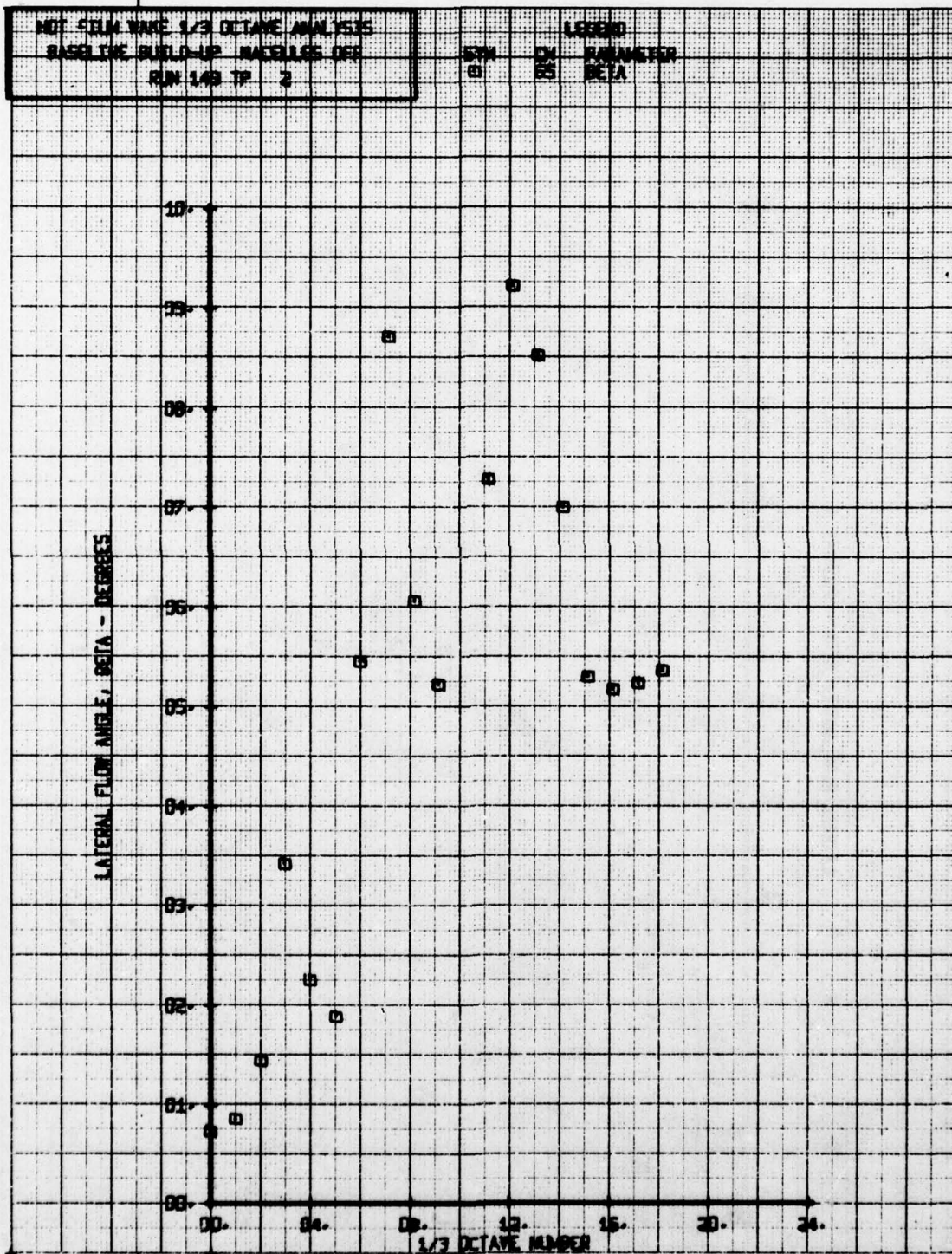
NOT FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE BUILD-UP NUCLEUS ONT  
 RUN 149 TP 9

SYN CH  
 05 66  
 LEGEND  
 PARAMETER  
 ALPHA

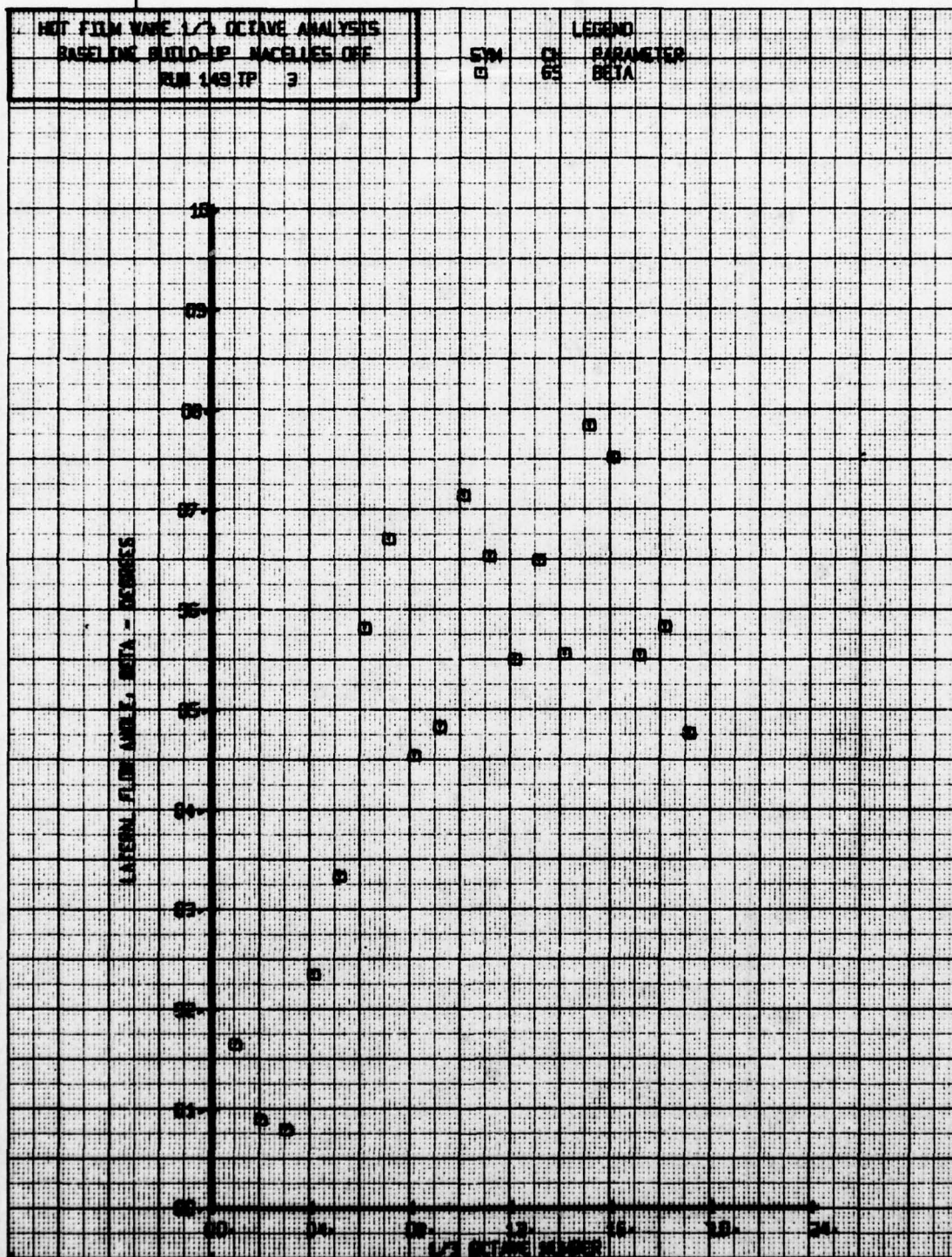








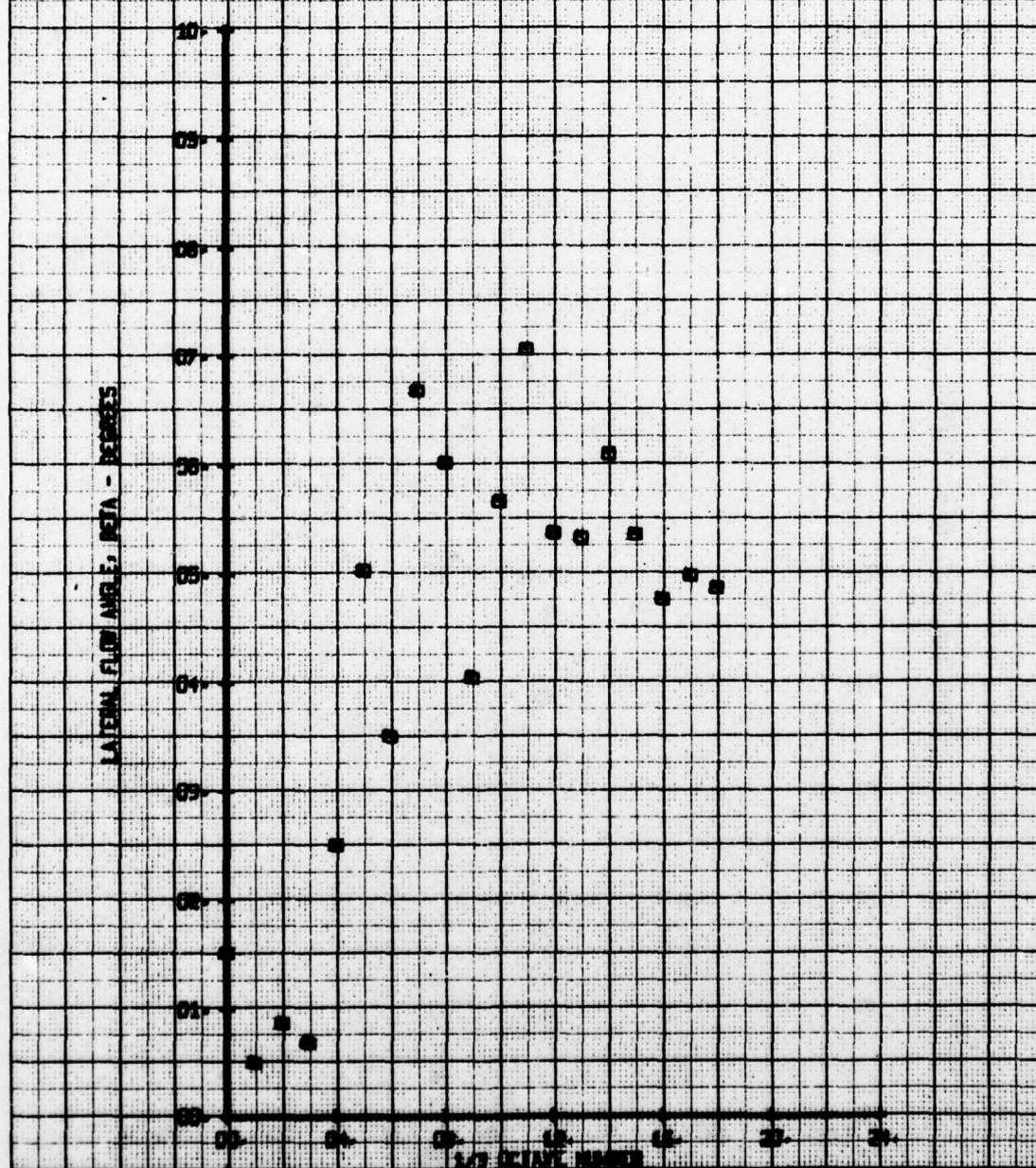




NOT FILM WAVE 1/3 OCTAVE ANALYSIS  
 BANDLINE BUILD-UP NACULLES OFF  
 RUN 148 1P 4

LENSES  
 CH 65  
 PARAMETER  
 BETA

LATERAL FLOW ANGLE, BETA - DEGREES

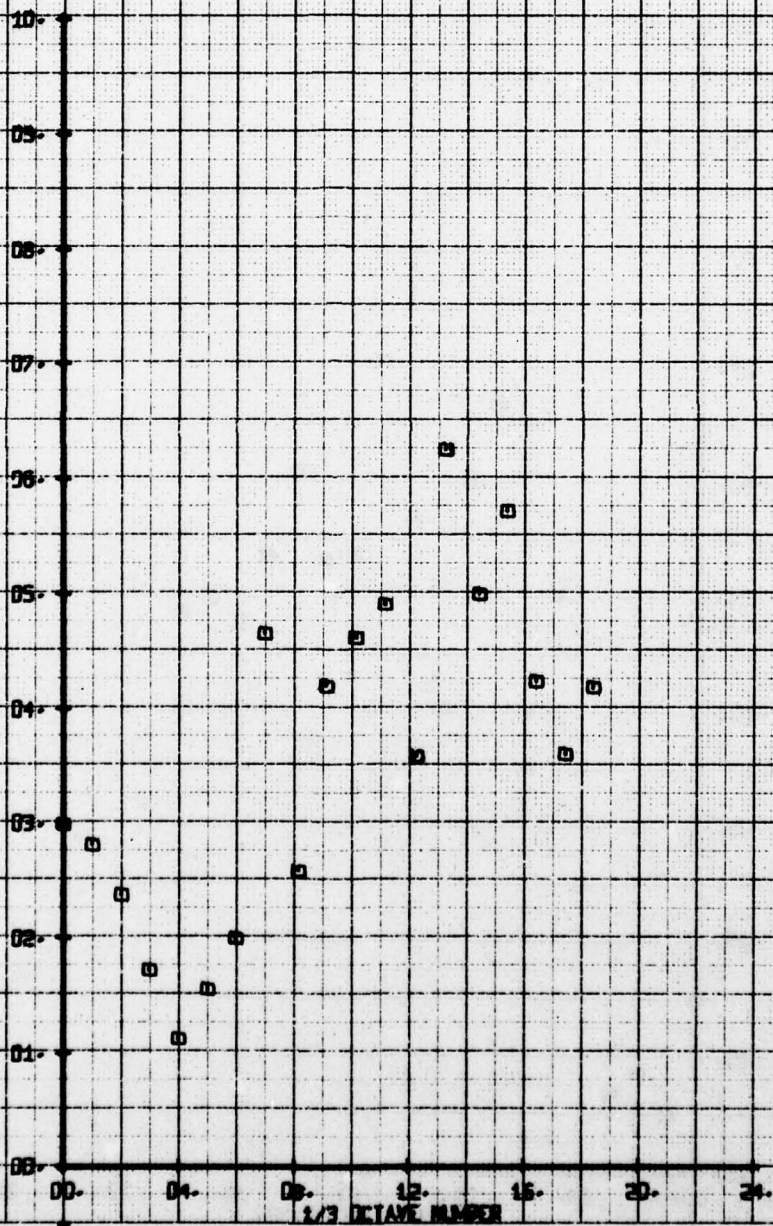




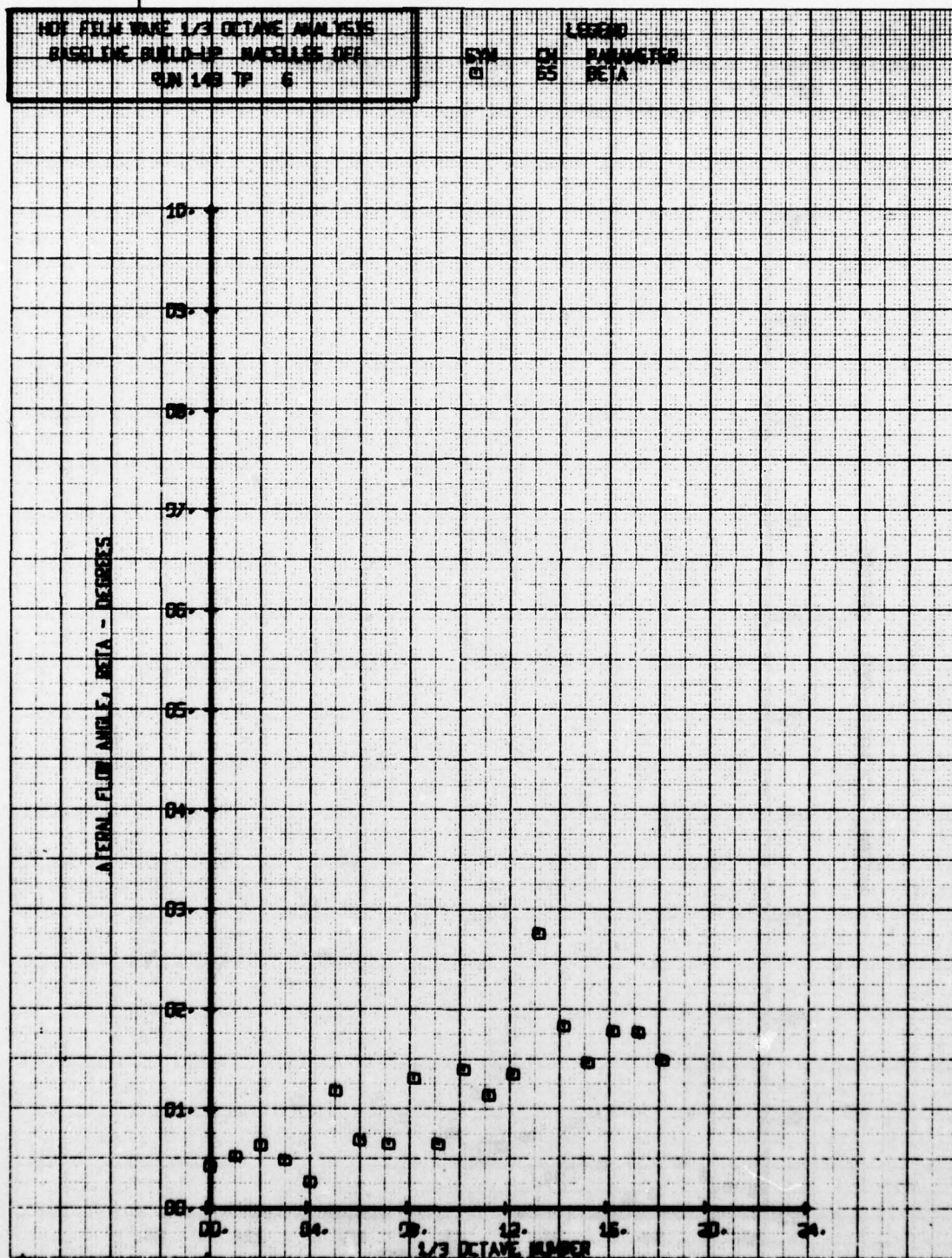
HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE BUILD-UP NACKLES OFF  
 RUN 148 TP 5

LEGEND  
 SYM CH PARAMETER  
 □ 55 BETA

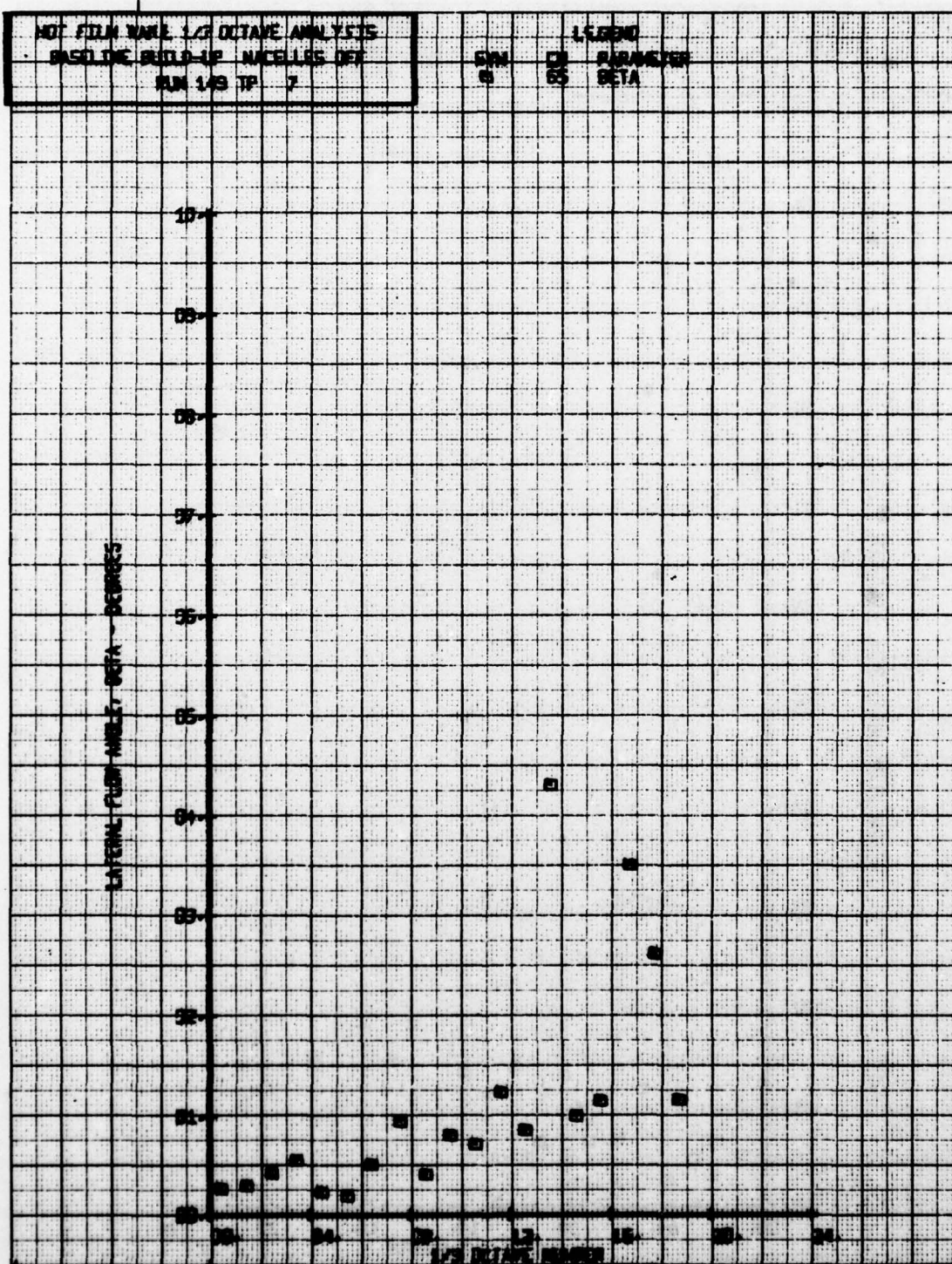
ATERNAL FLOW ANGLE, BETA - DEGREES



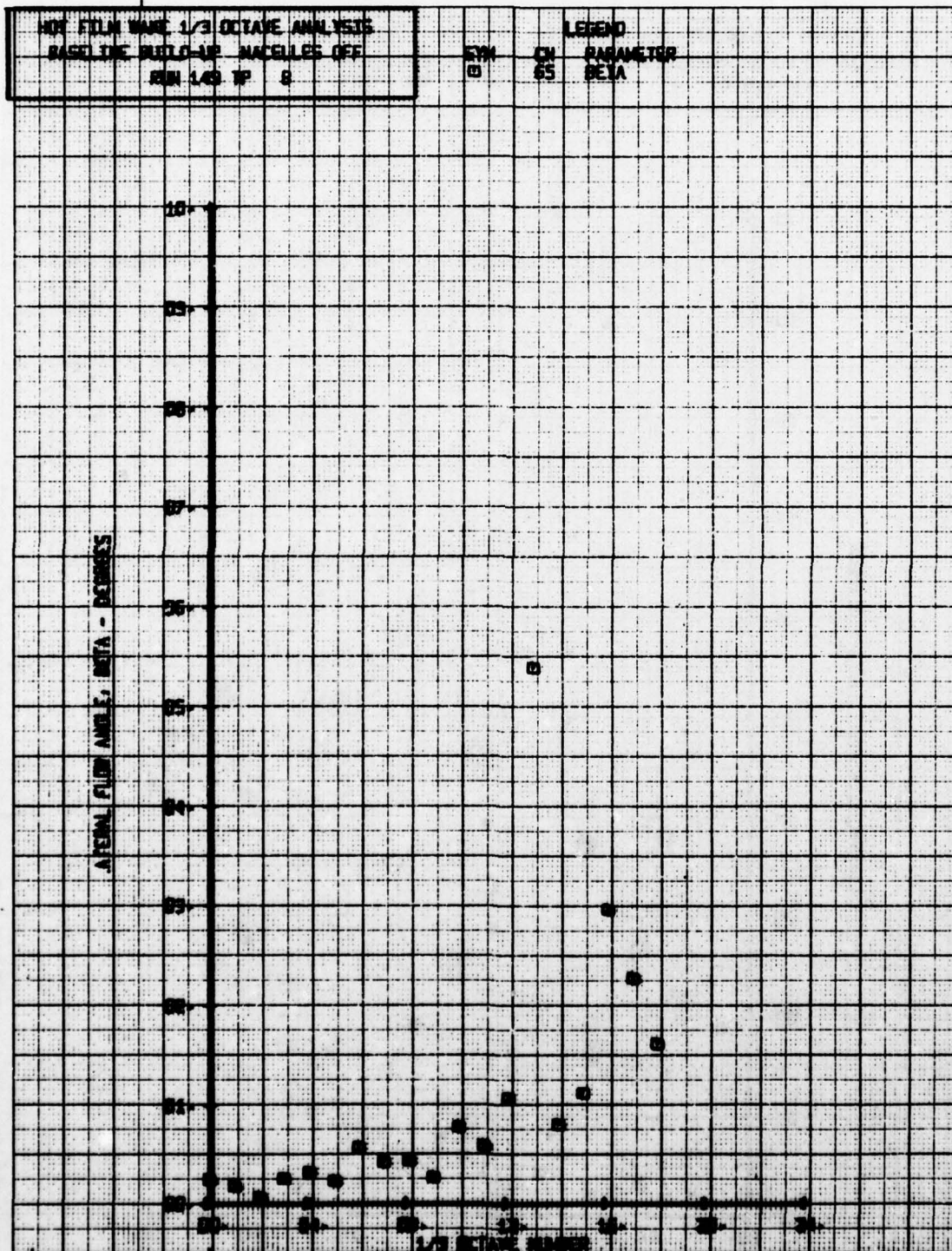




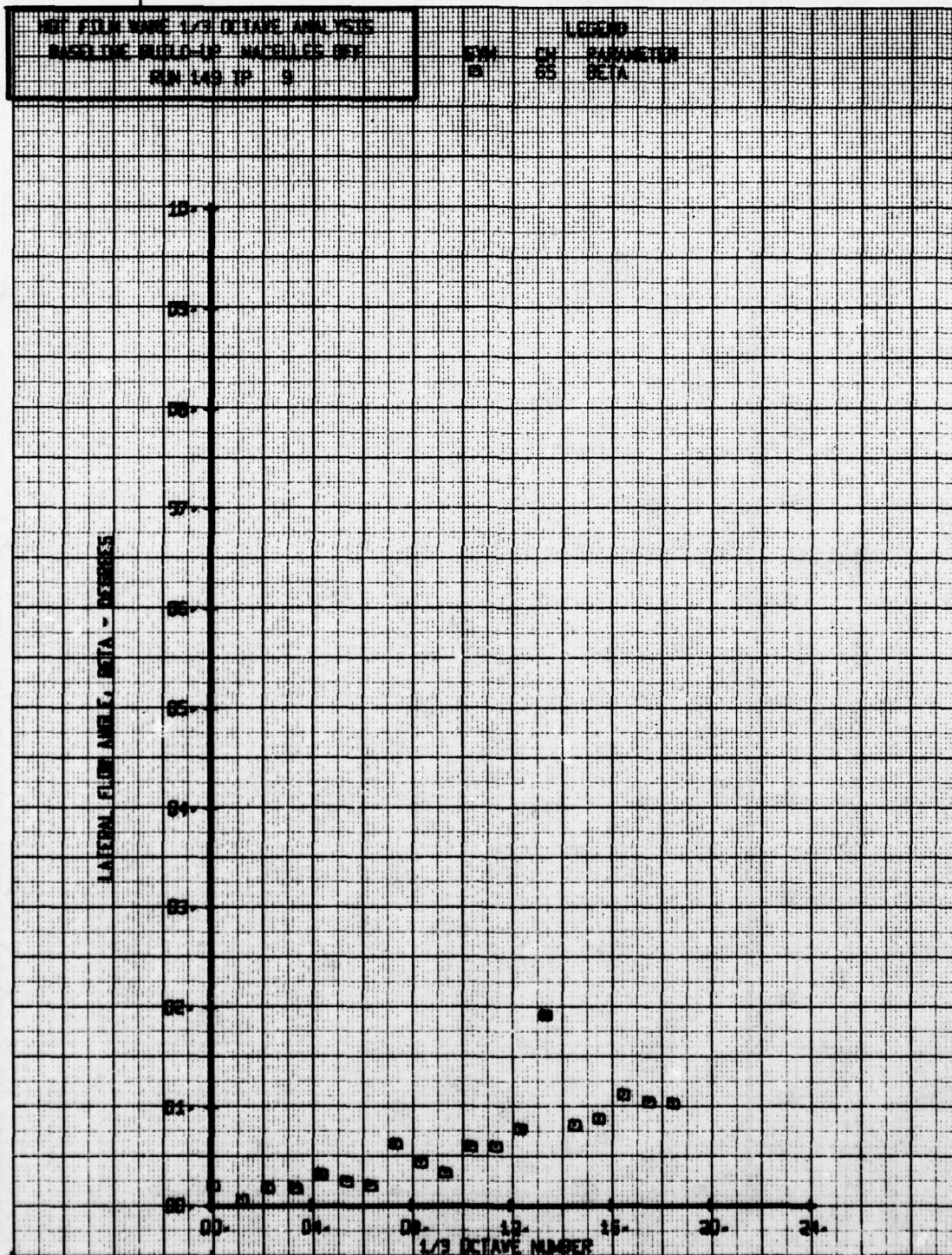
SYN		LEGEND	
6	65	65	PARAMETER
		BETA	
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
29	29	29	29
30	30	30	30
31	31	31	31
32	32	32	32
33	33	33	33
34	34	34	34
35	35	35	35
36	36	36	36
37	37	37	37
38	38	38	38
39	39	39	39
40	40	40	40
41	41	41	41
42	42	42	42
43	43	43	43
44	44	44	44
45	45	45	45
46	46	46	46
47	47	47	47
48	48	48	48
49	49	49	49
50	50	50	50
51	51	51	51
52	52	52	52
53	53	53	53
54	54	54	54
55	55	55	55
56	56	56	56
57	57	57	57
58	58	58	58
59	59	59	59
60	60	60	60
61	61	61	61
62	62	62	62
63	63	63	63
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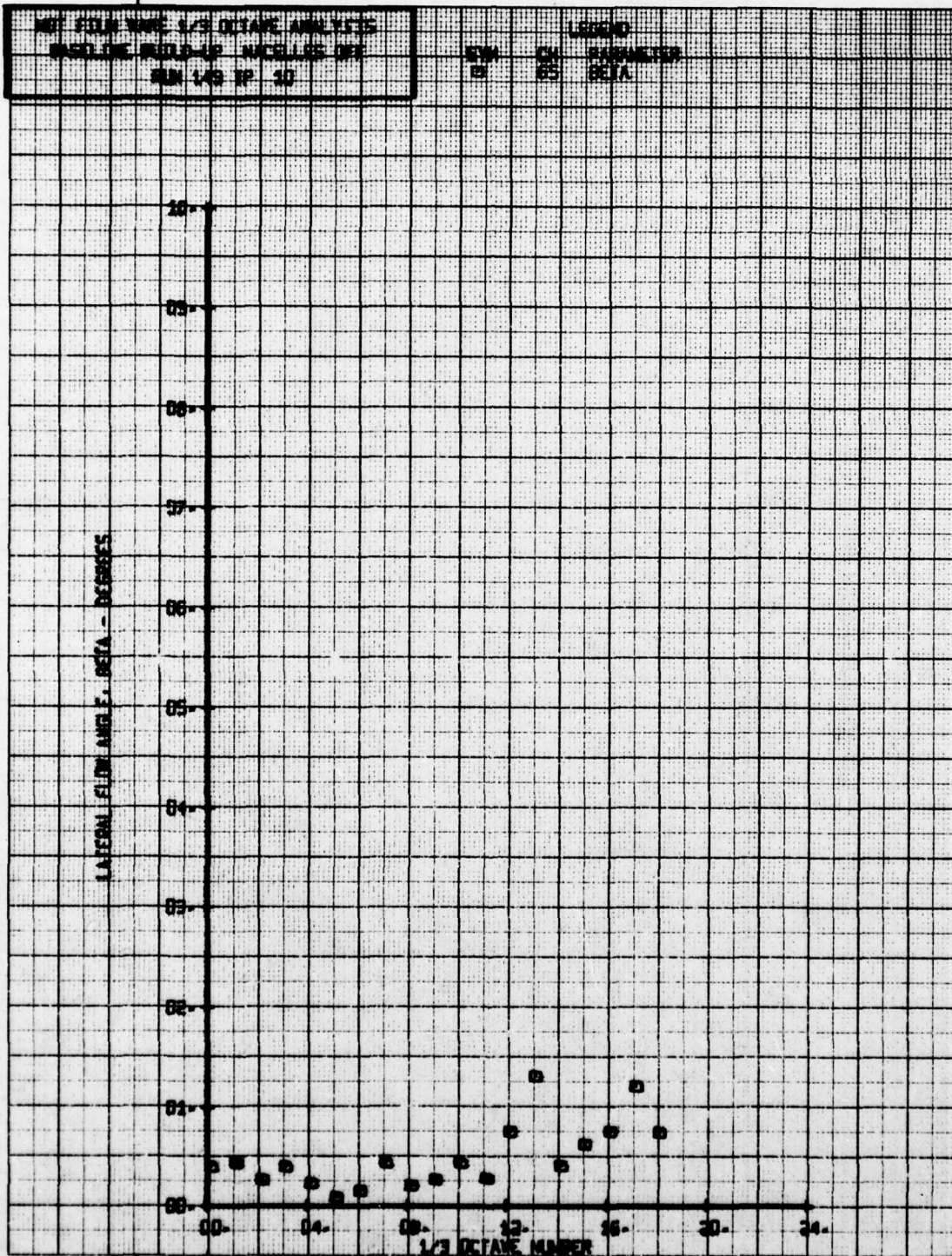
















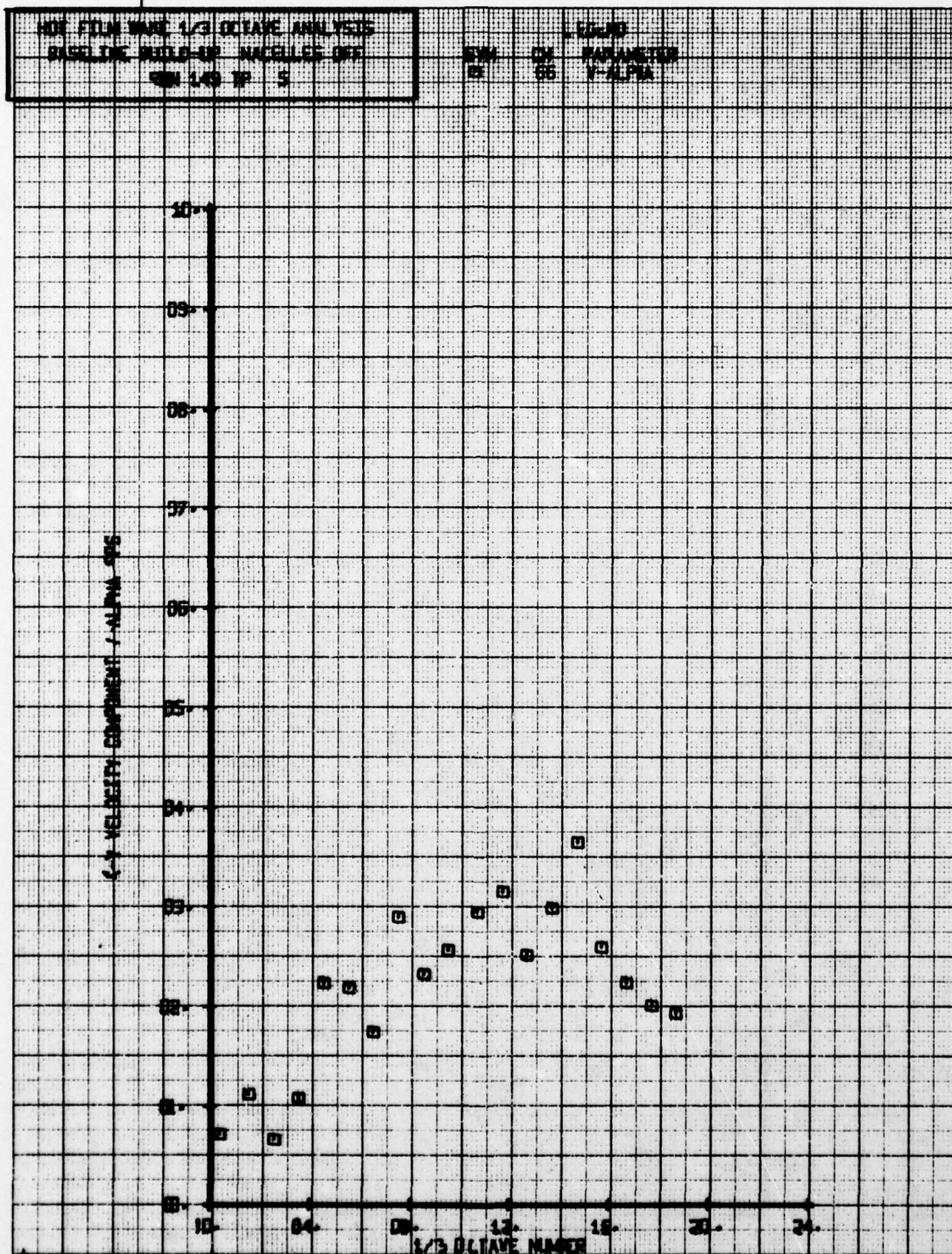




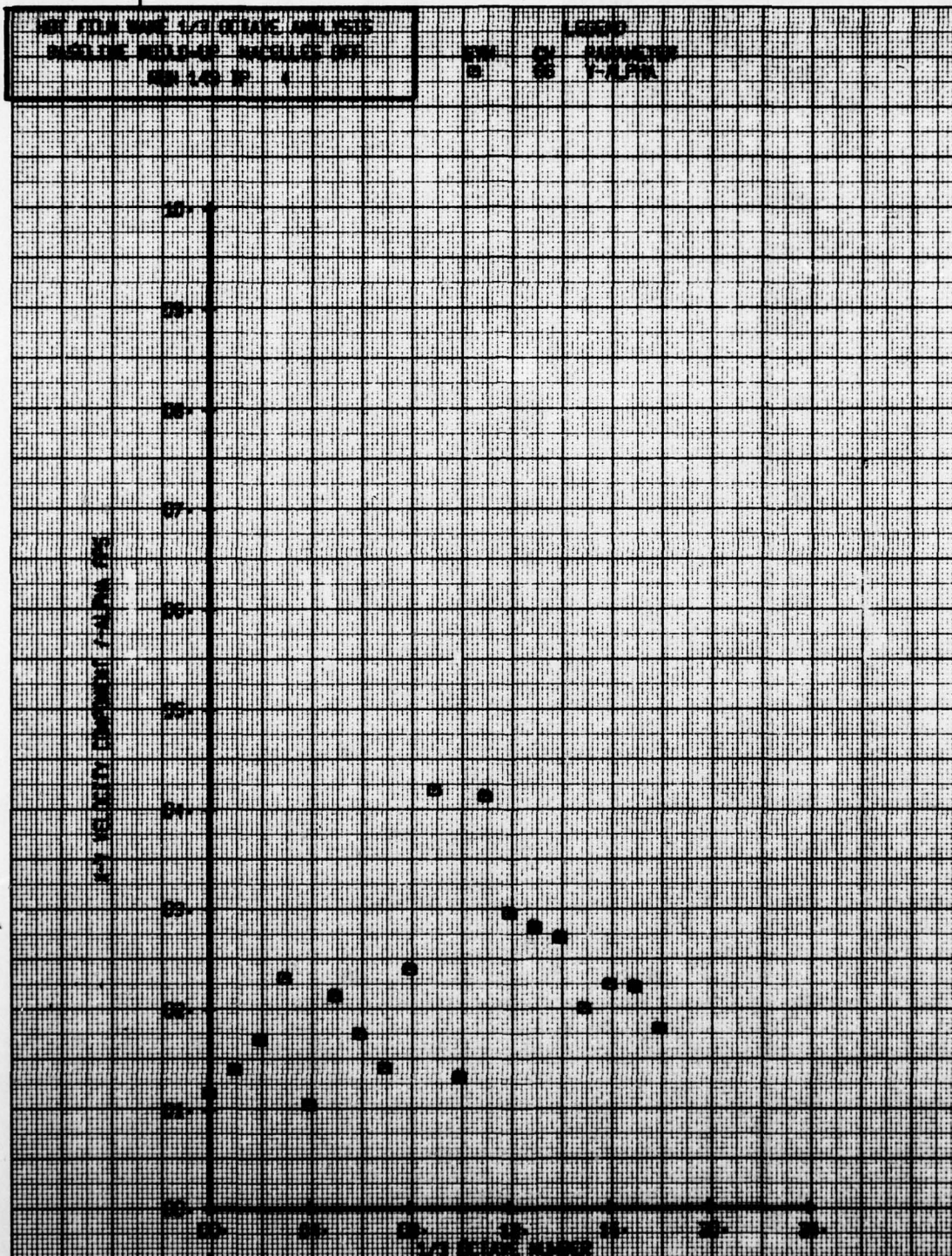
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504	CM	PARAMETER
13	66	V-ALPHA

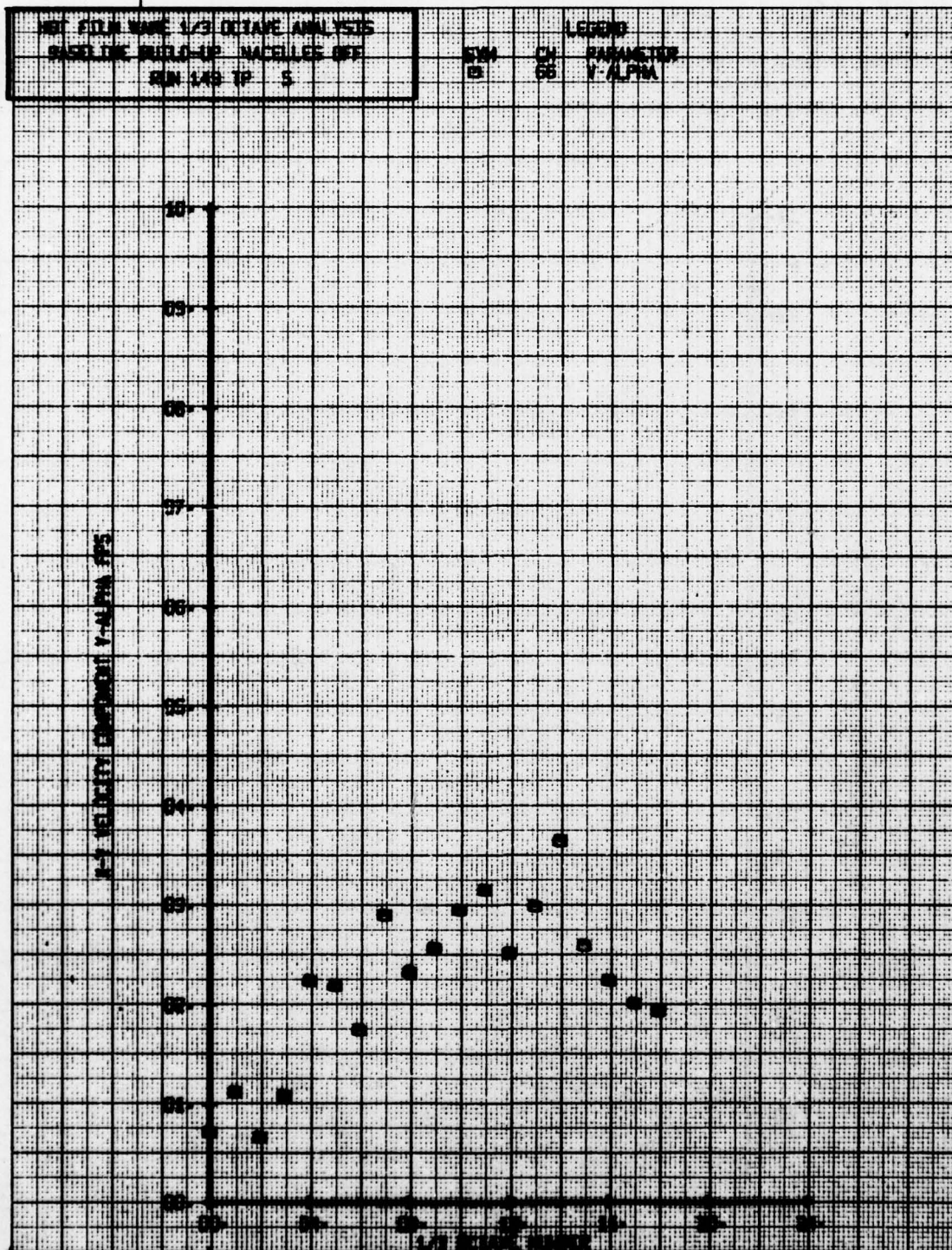














FOR FILM NO. 1-3 OCTAVE ANALYSIS

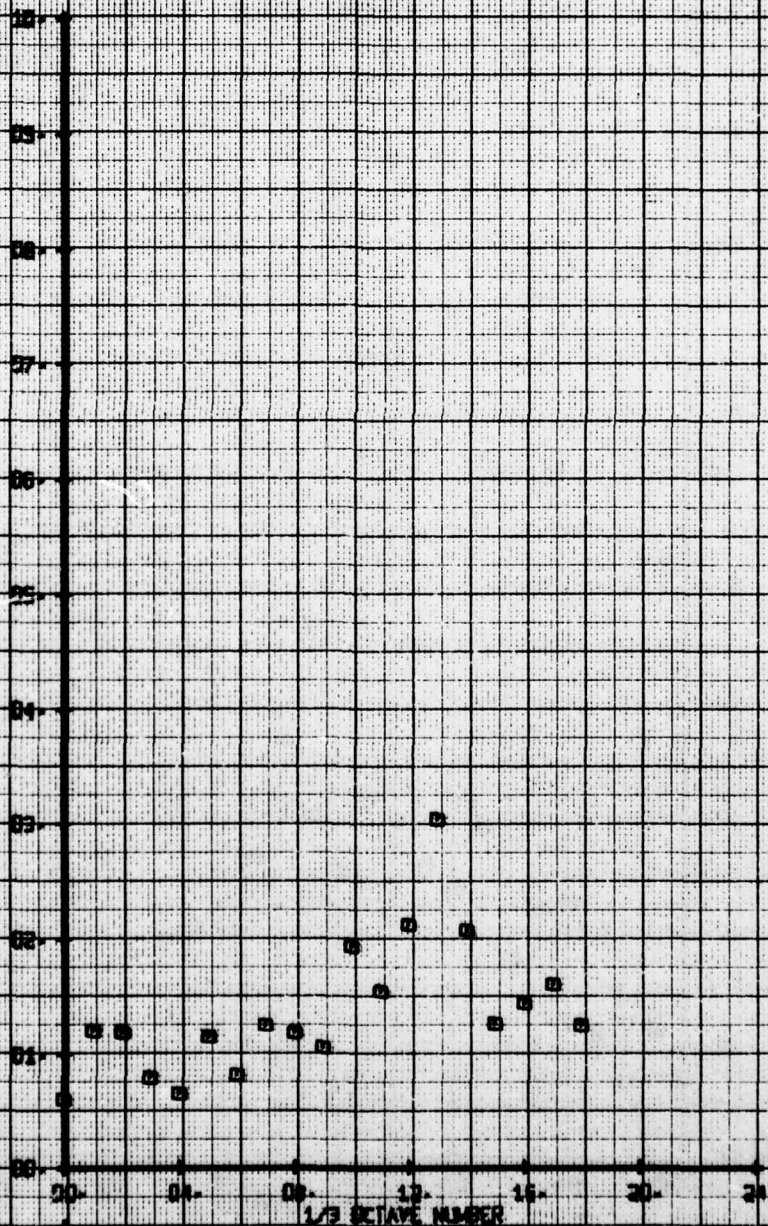
BASELINE BUILD-UP ANGLES OFF

FOR LAG 7 6

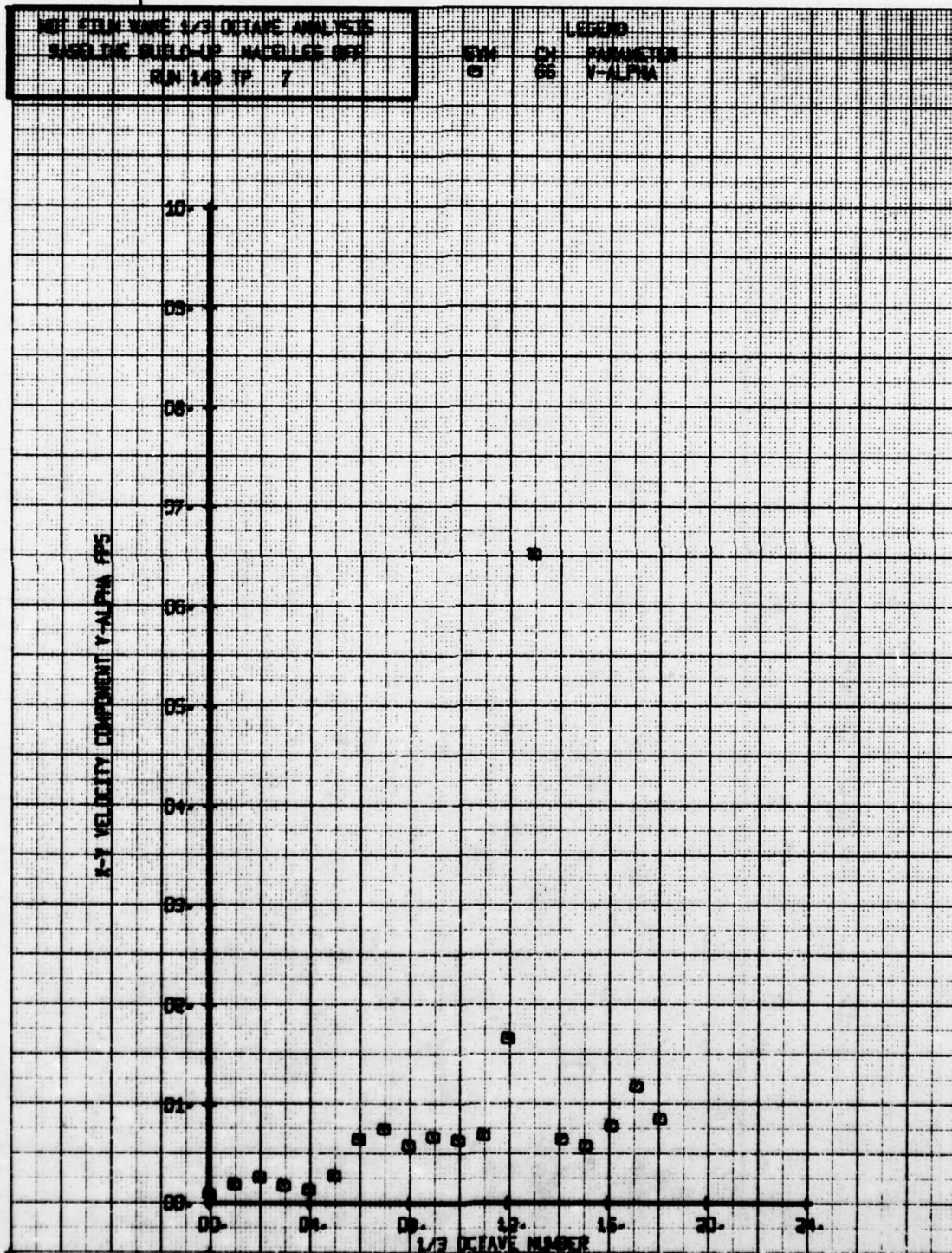
LEGEND

SYN	ON	PARAMETER
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Y-VELOCITY COMPONENT /-ALPHA PPS



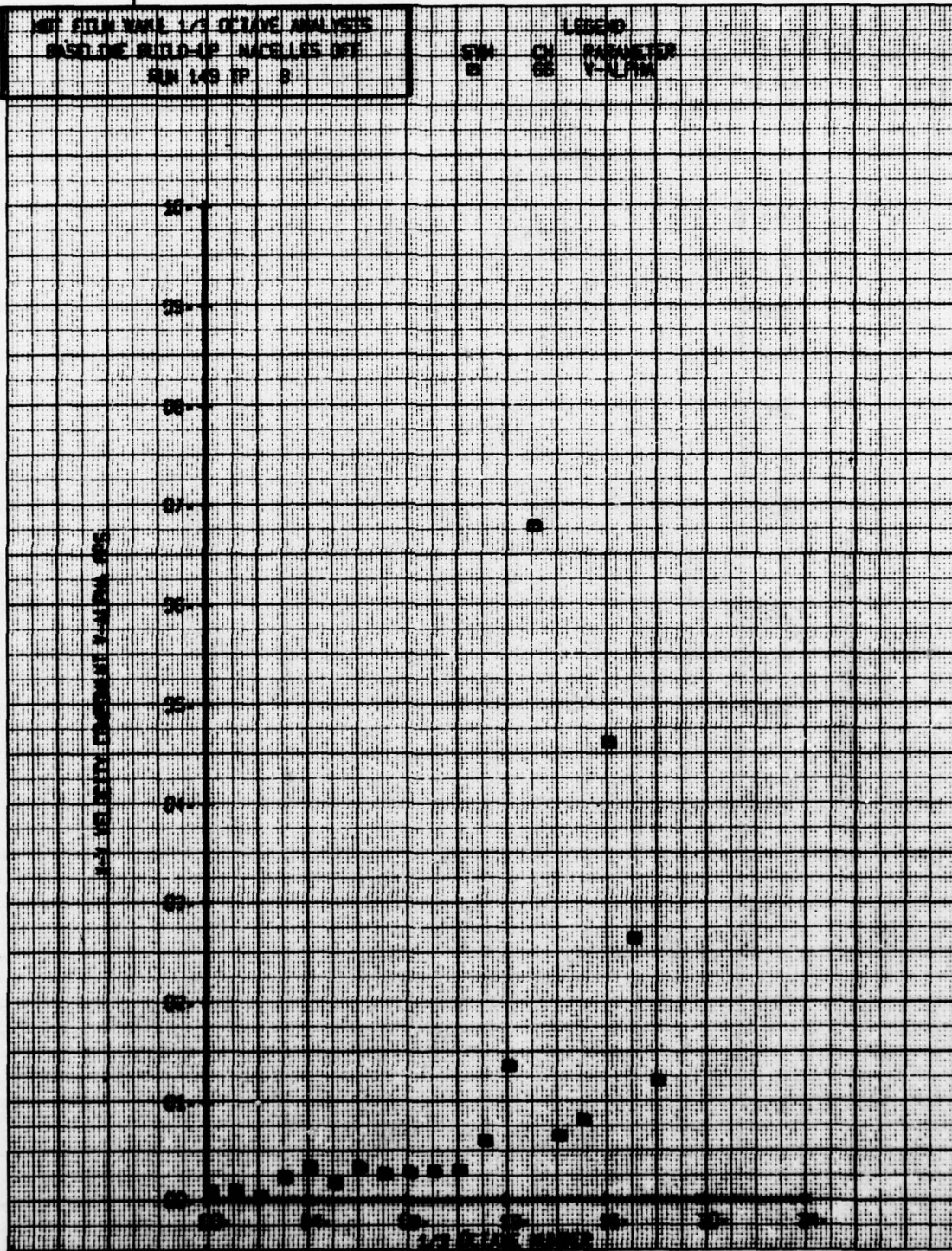




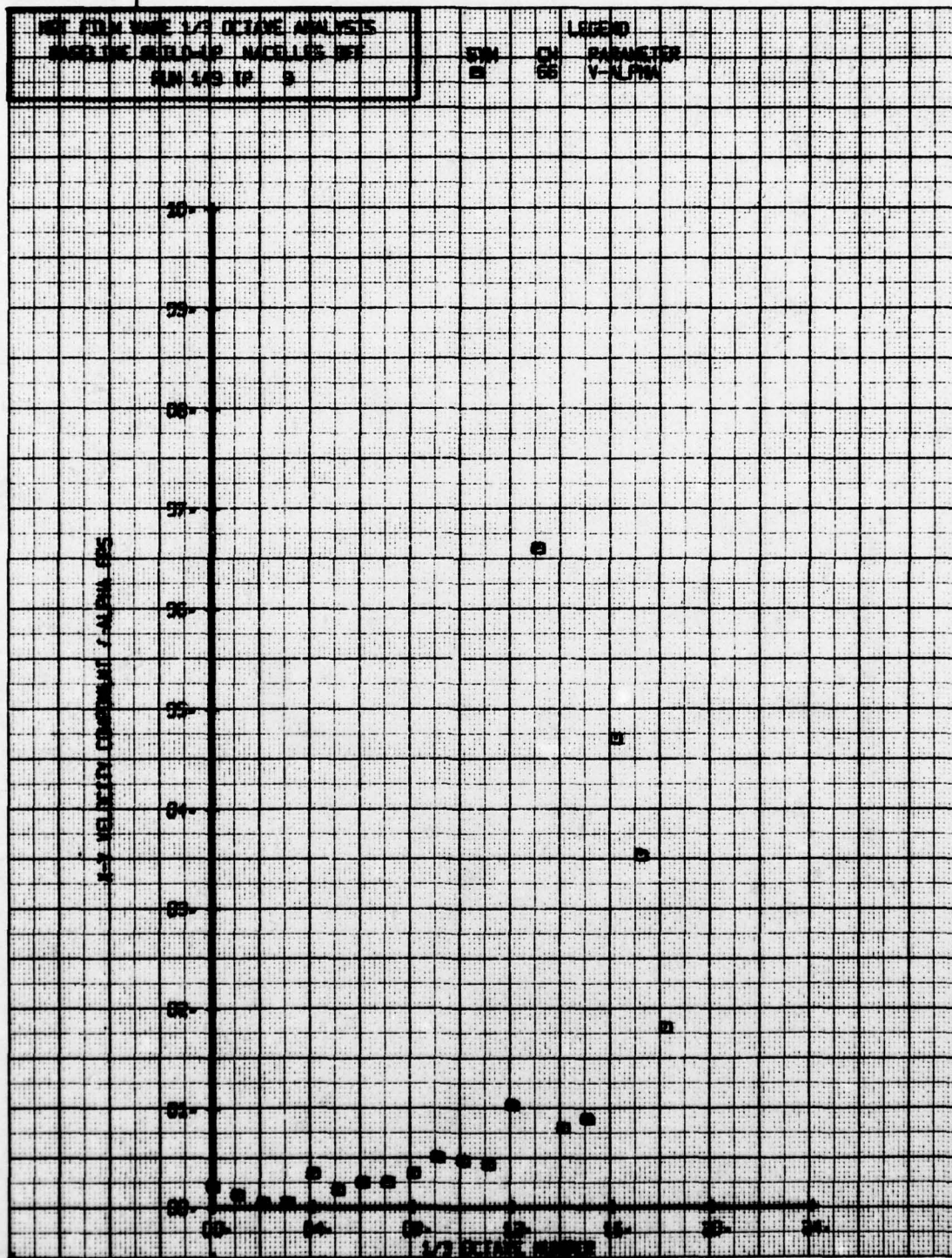
NET FILM NAME 1/3 DETAVE ANALYSIS  
 BASELINE BUILD-UP ANALYSIS DET  
 RUN 143 IP 3

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1.1 VELOCITY COMPONENT 1.1/1000 FPS





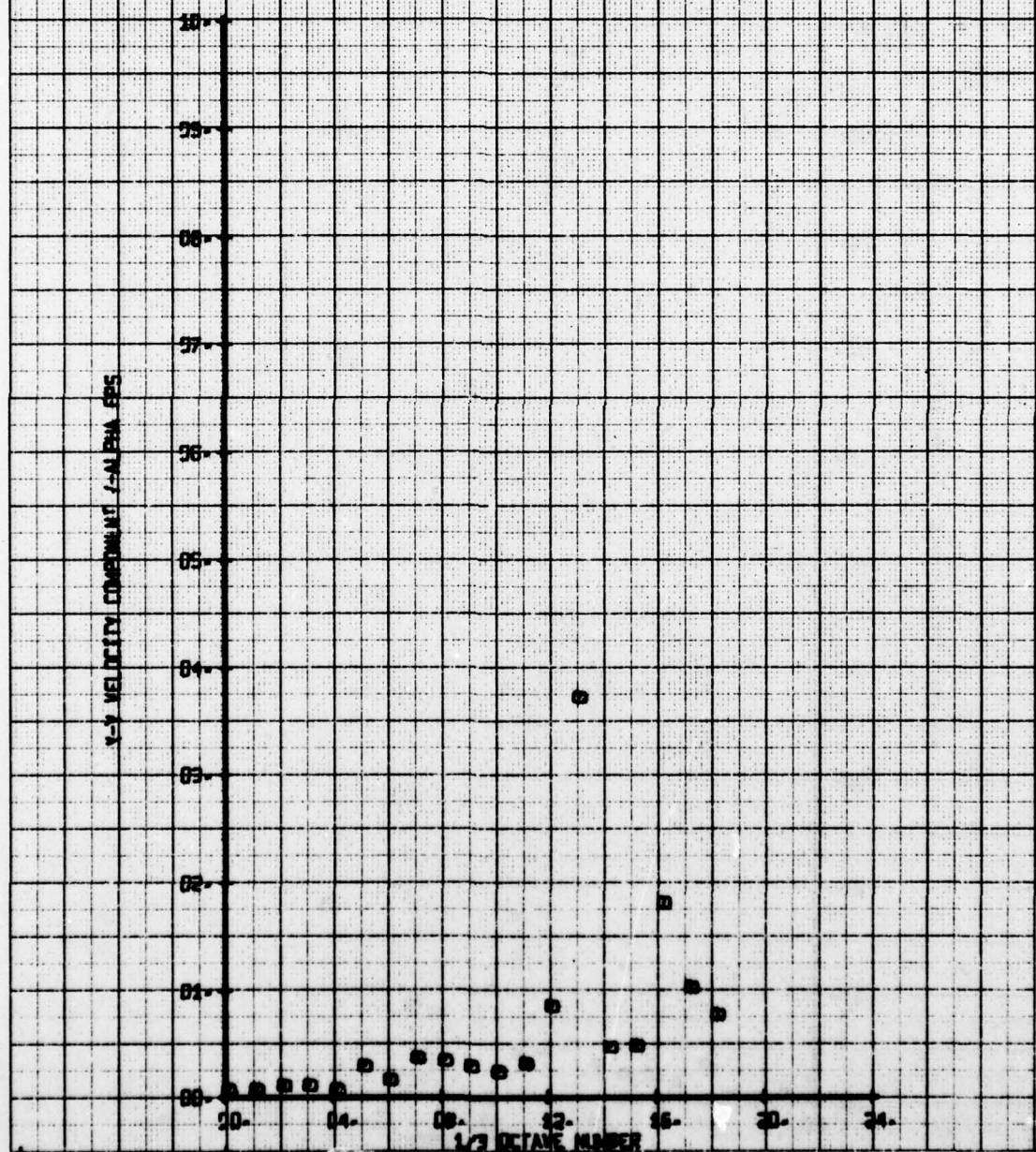


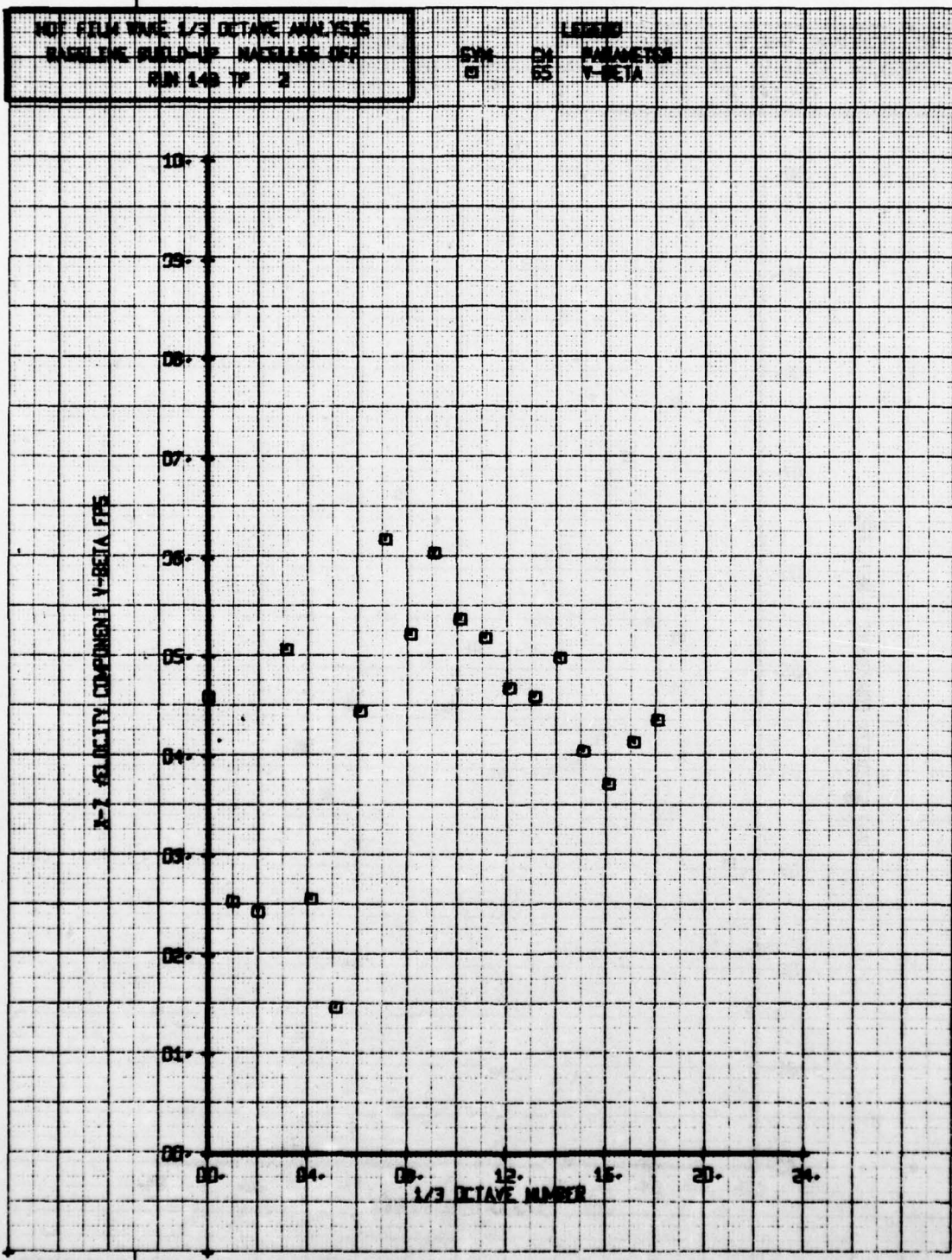


NOT FILM WARE 1/3 OCTAVE ANALYSIS  
 BASED ON MEASURED-UP NOISE LIES OFF  
 SUN 149 IP 10

SYM	CH	PARAMETER
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V-V VELOCITY COMPONENT (-ALPHA FBS)





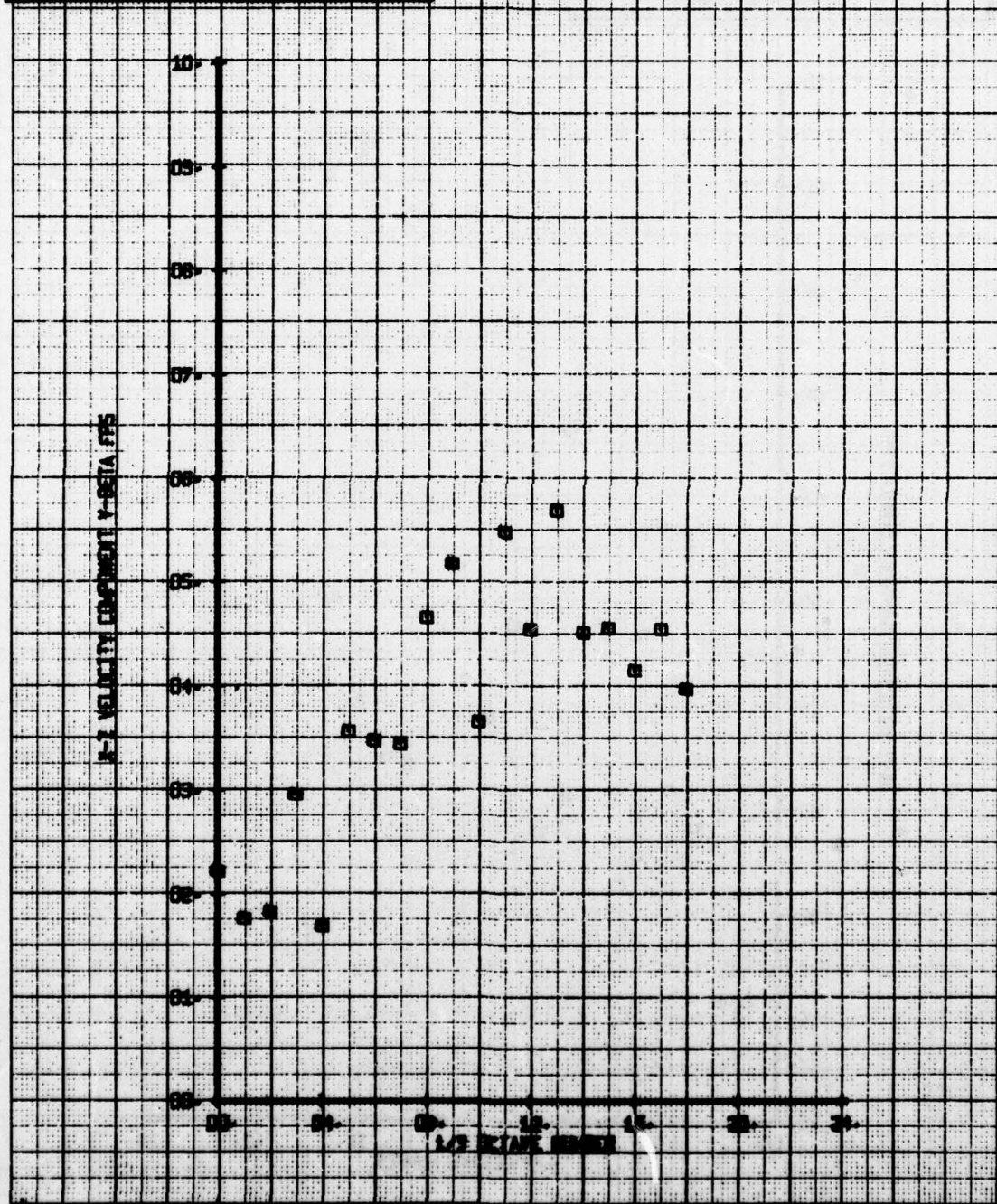


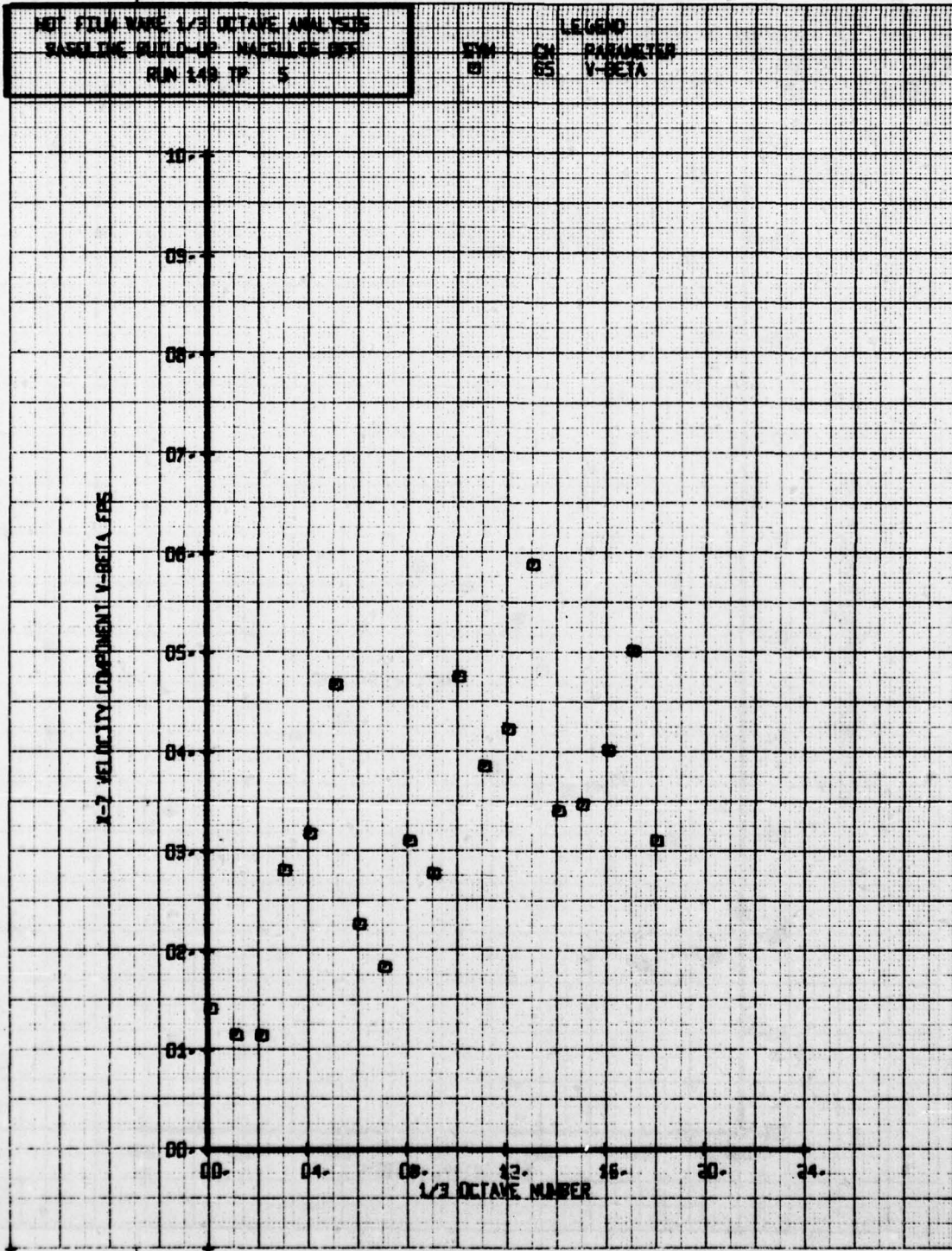




NET FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE BUILD-UP MAGNETS OFF  
 RUN 148 TP 4

SYN CH  
 05 05  
 PARAMETER  
 Y-BETA



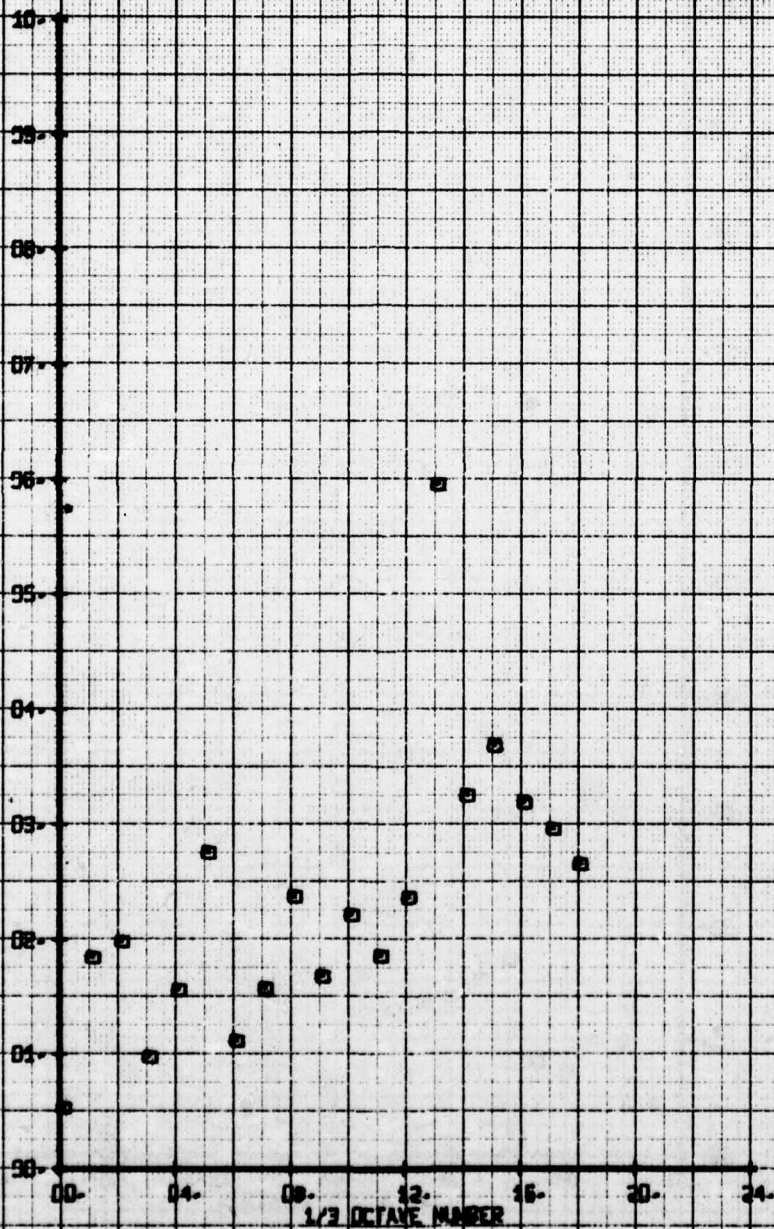


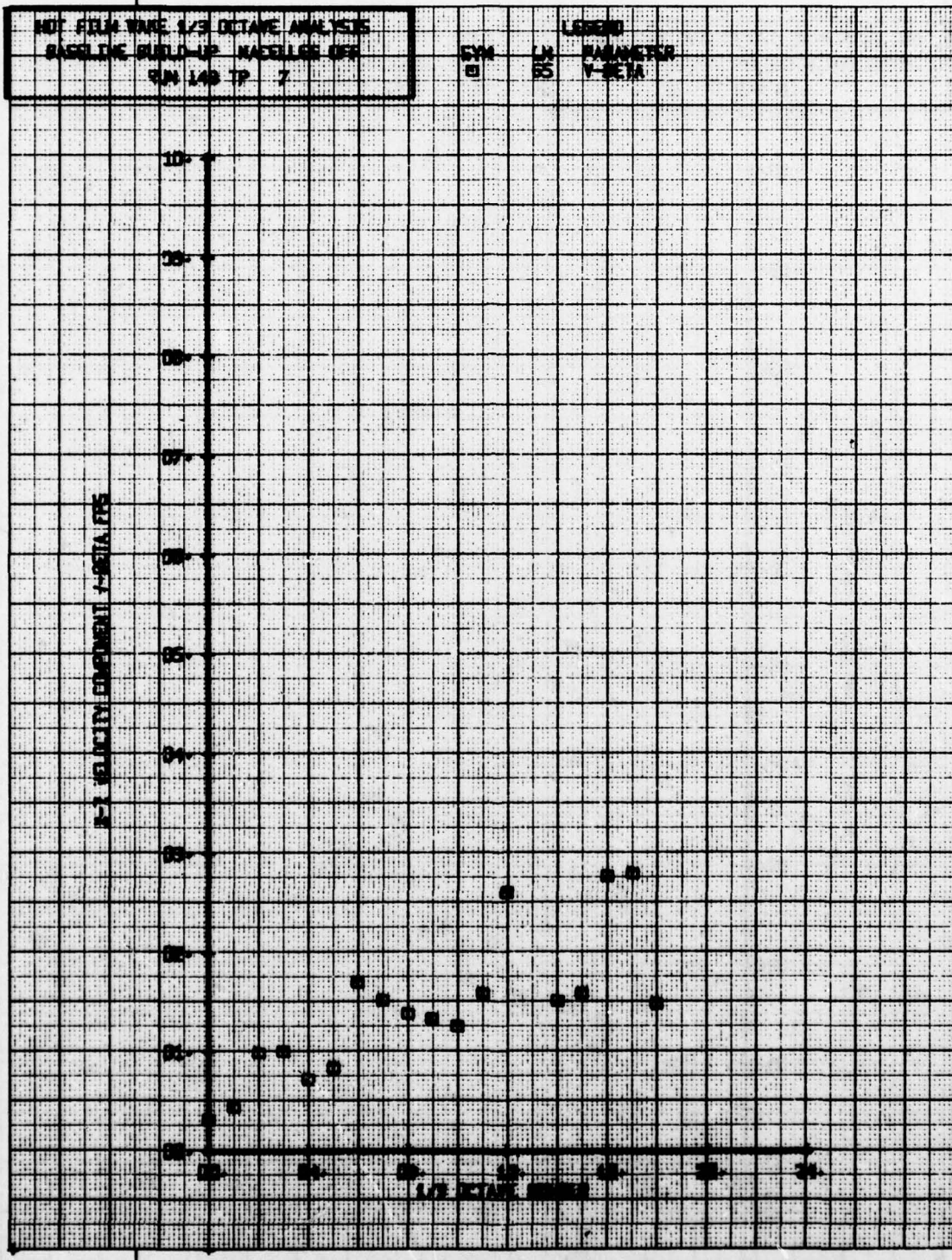


NOT FILM WIRE 1/3 OCTAVE ANALYSIS  
 BASELINE BUILD-UP NACELLE BEE  
 RUN 149 TP 5

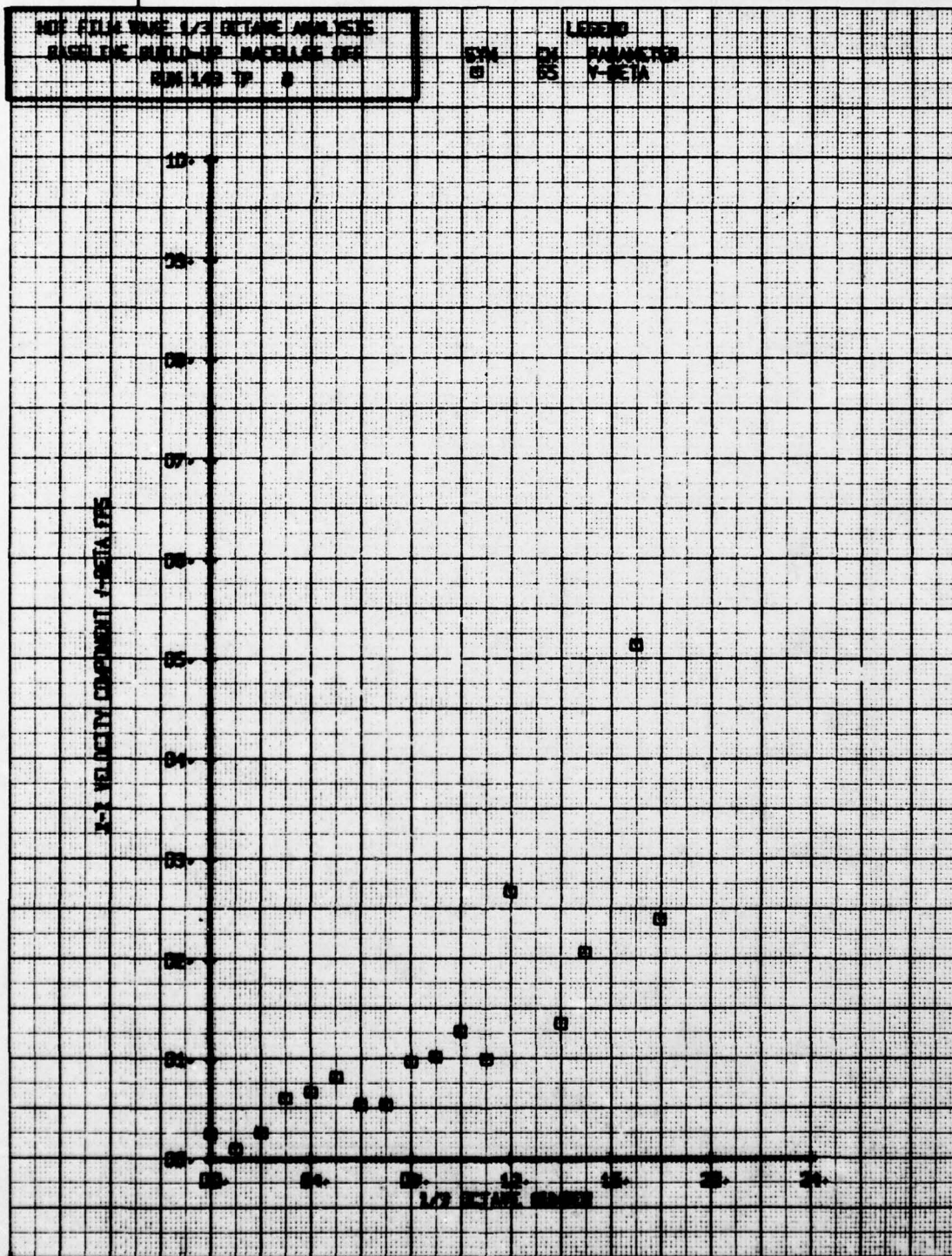
LEGEND  
 CH PARAMETER  
 65 V-BETA

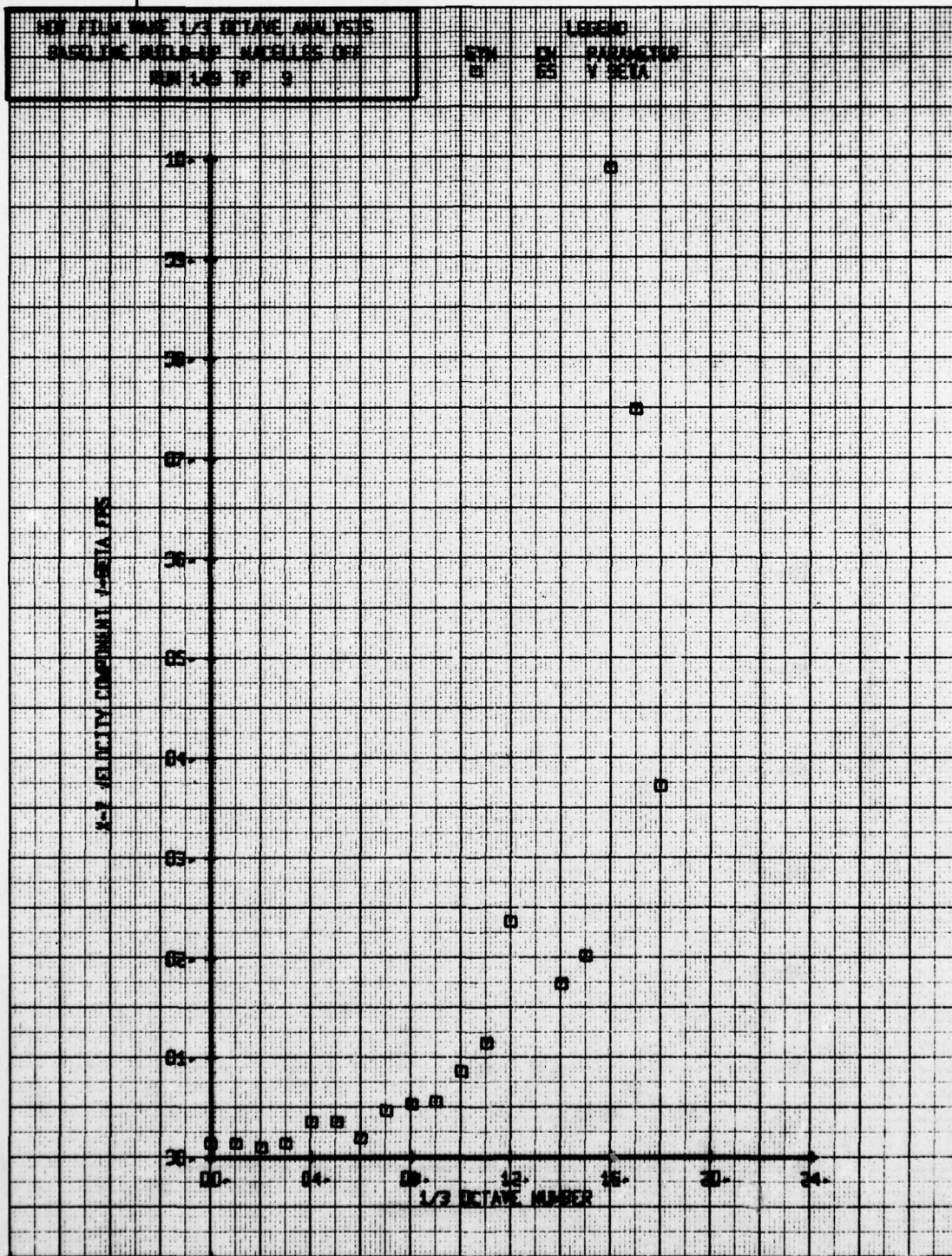
1-2 VELOCITY COEFFICIENT 1-8-14.5PS



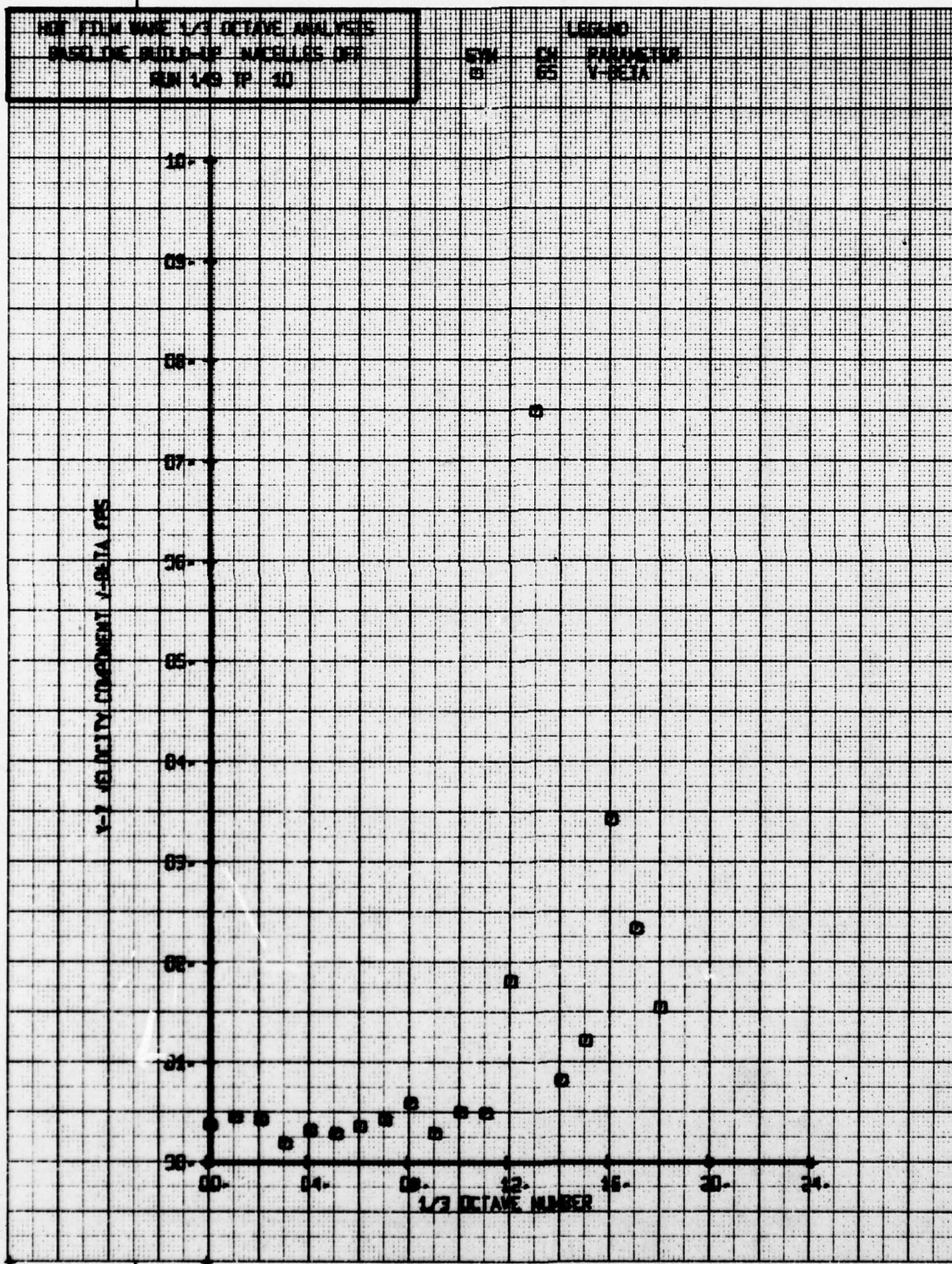


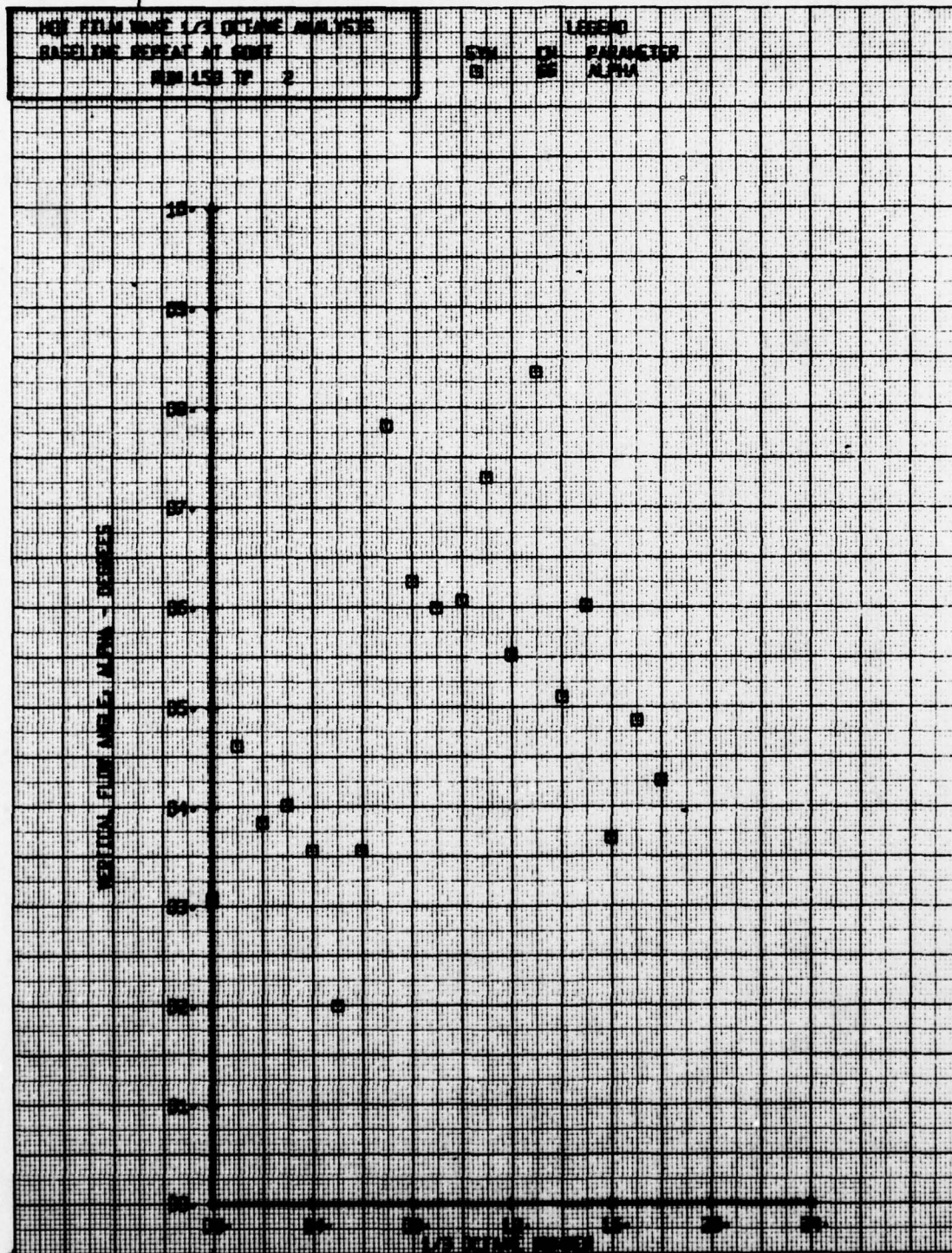




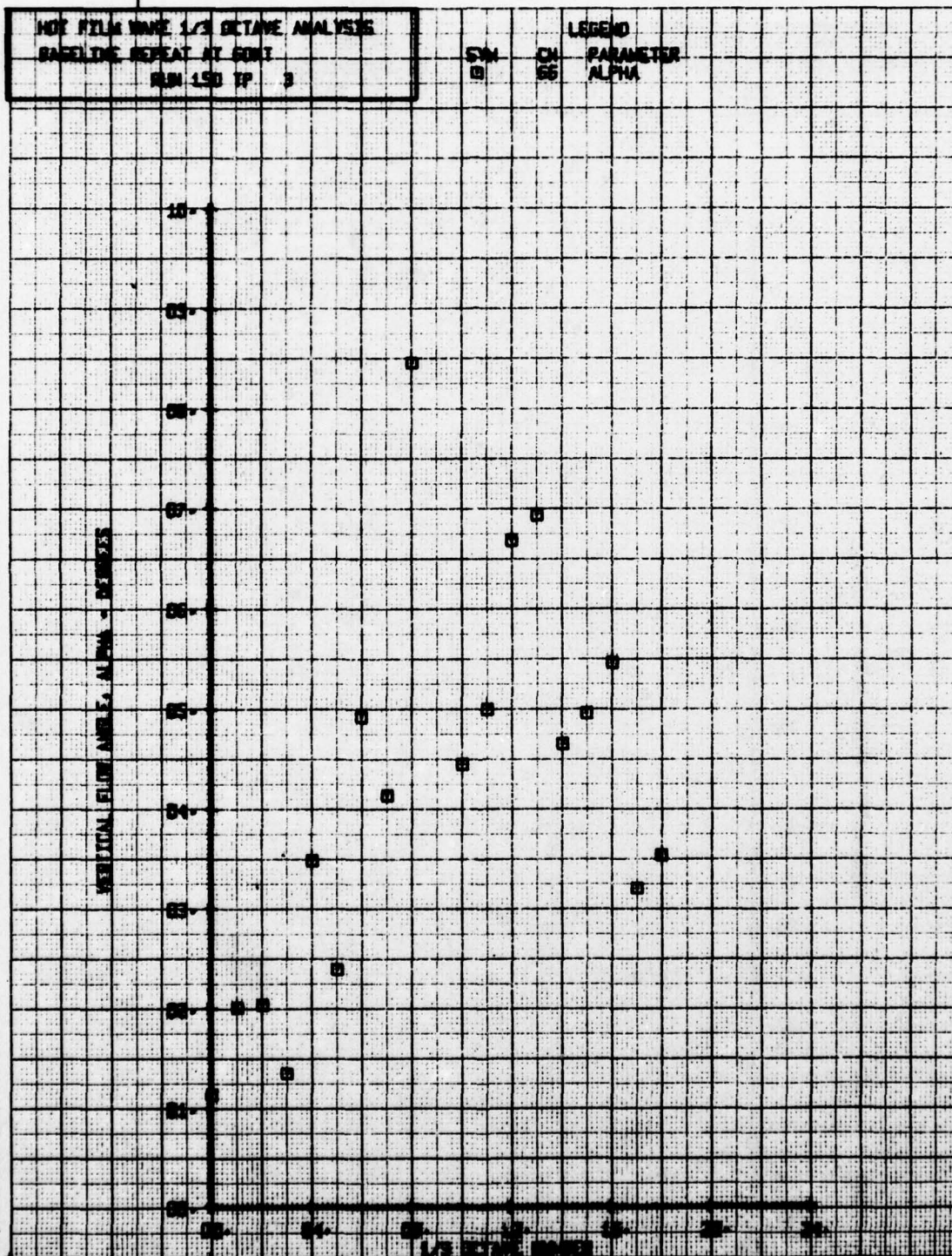


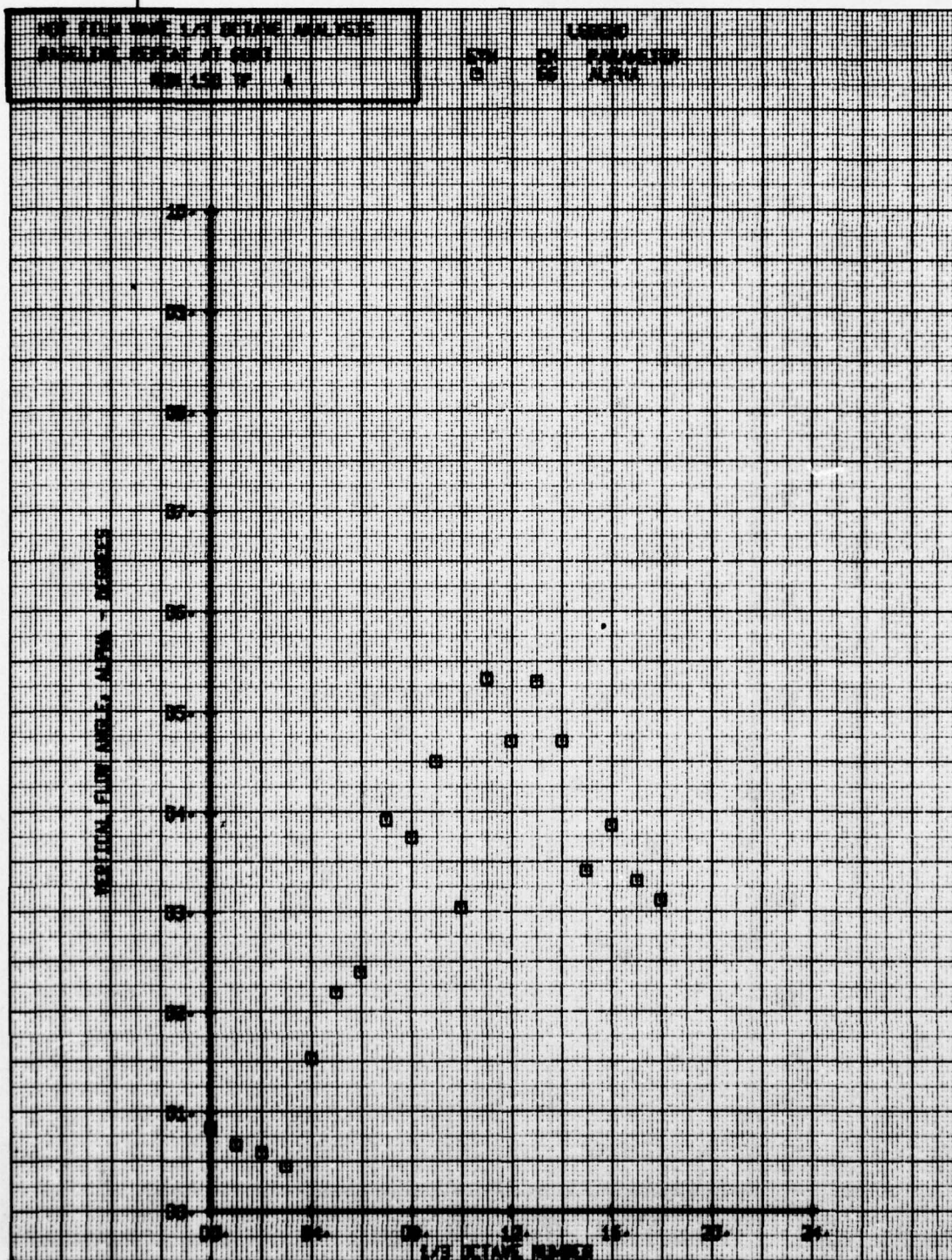




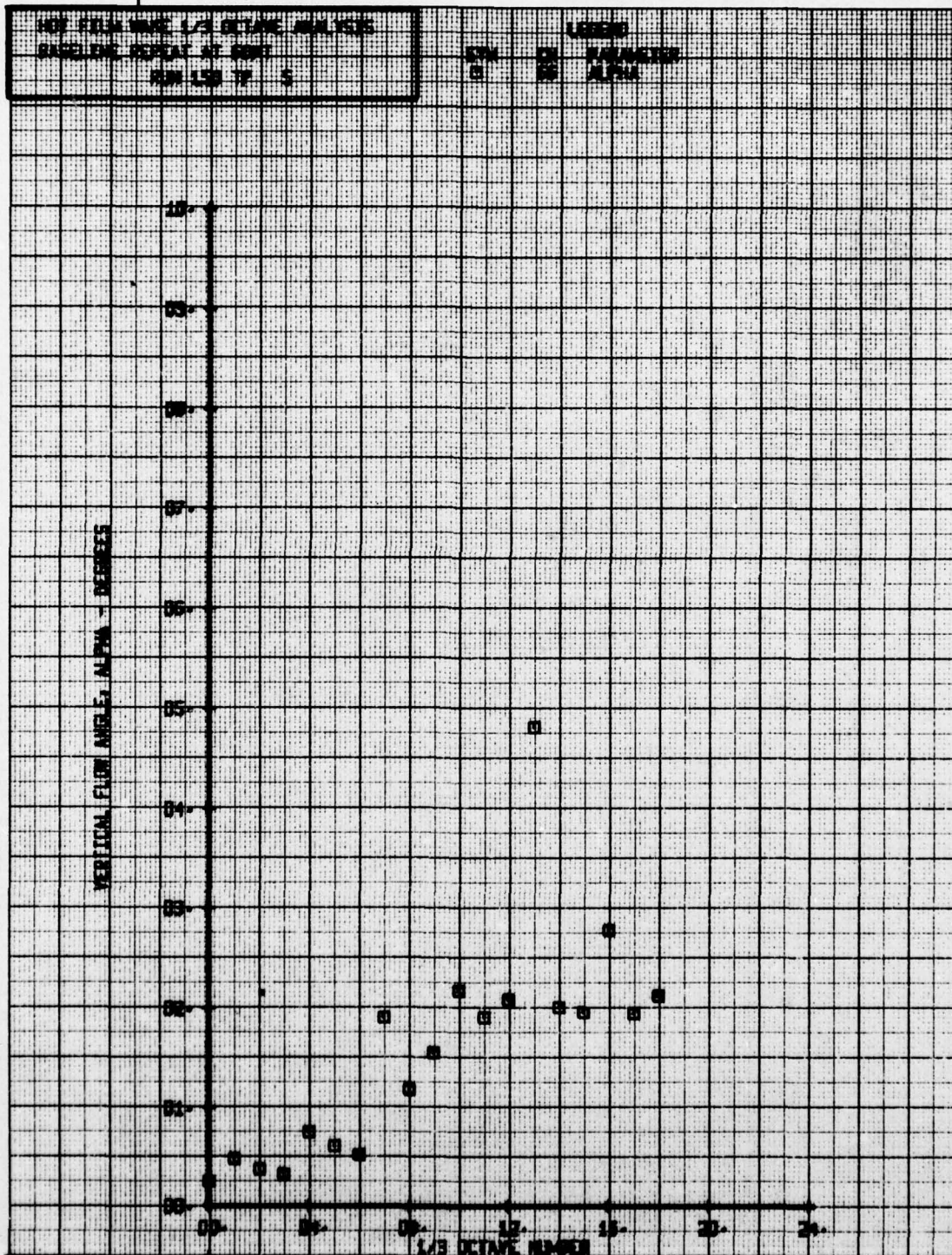


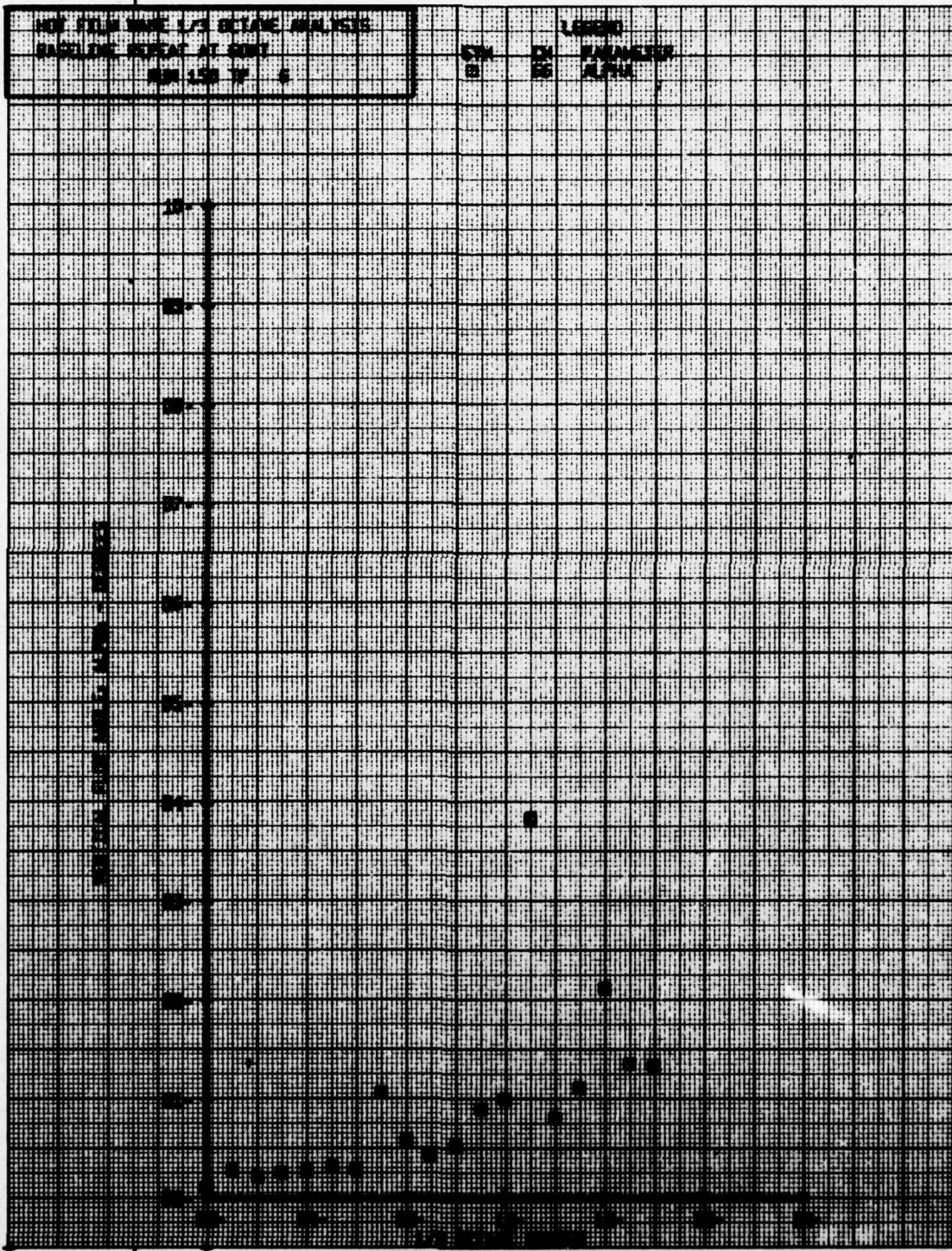




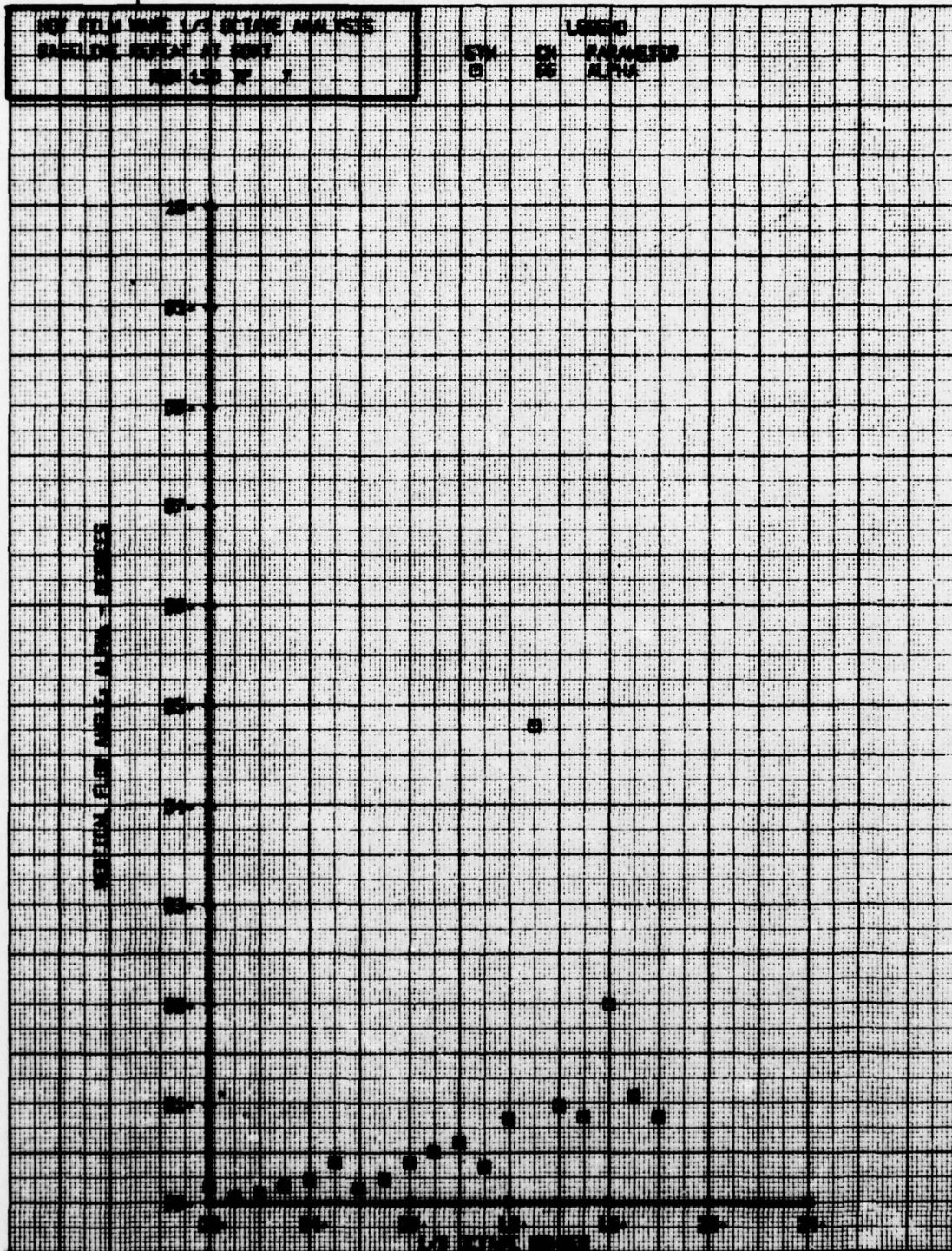








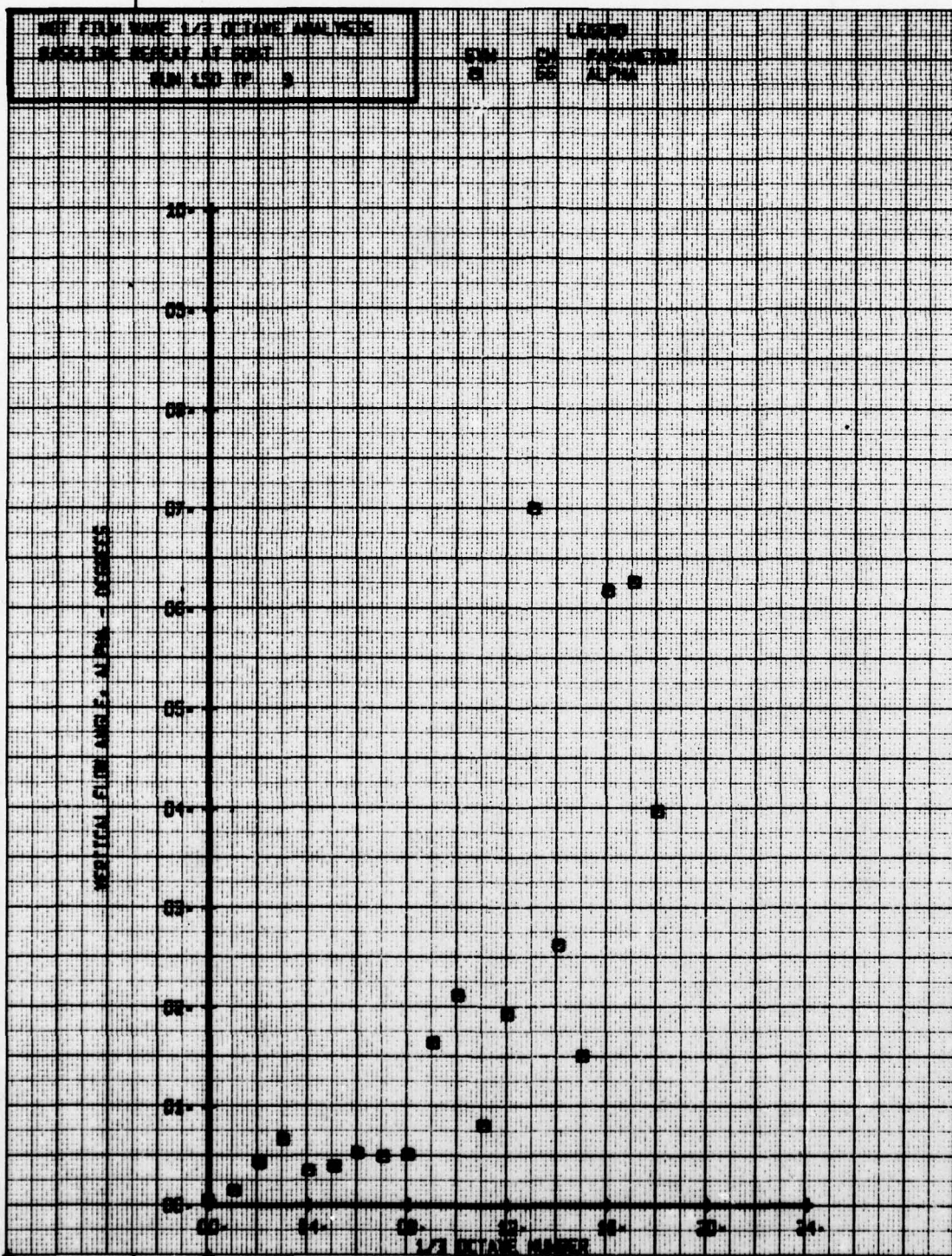




DATE	NAME	ADDRESS
10/10/66	JOHN	12345

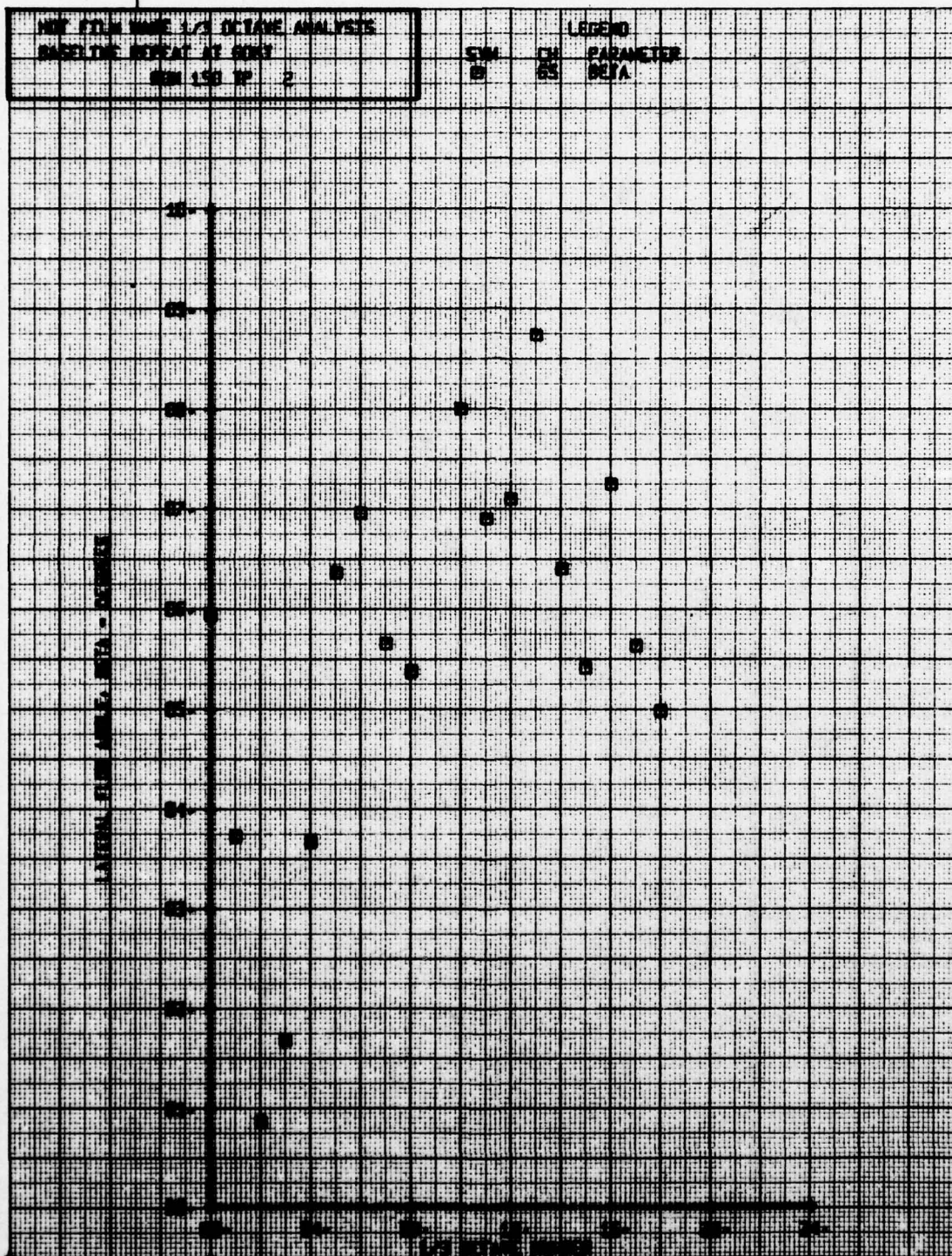


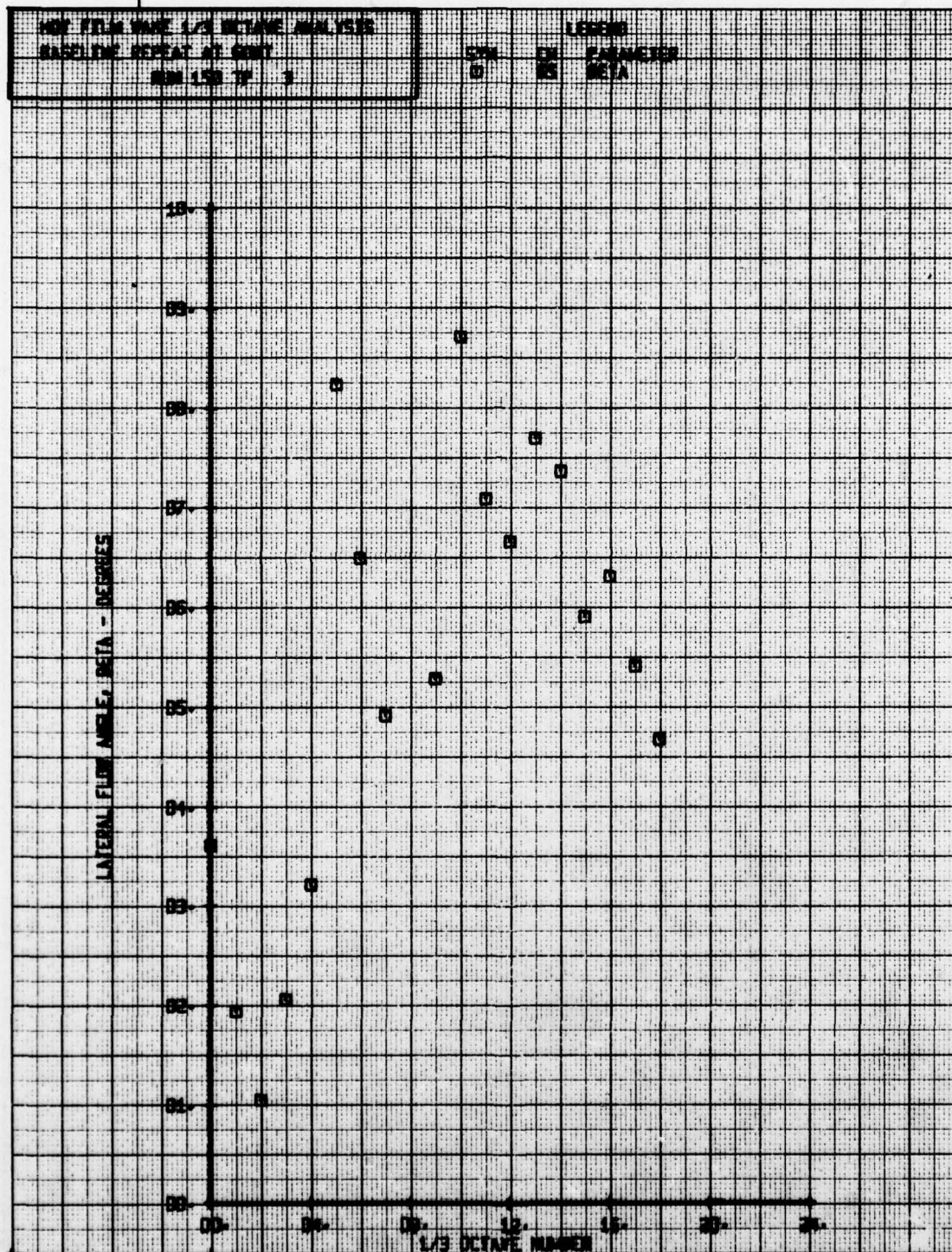




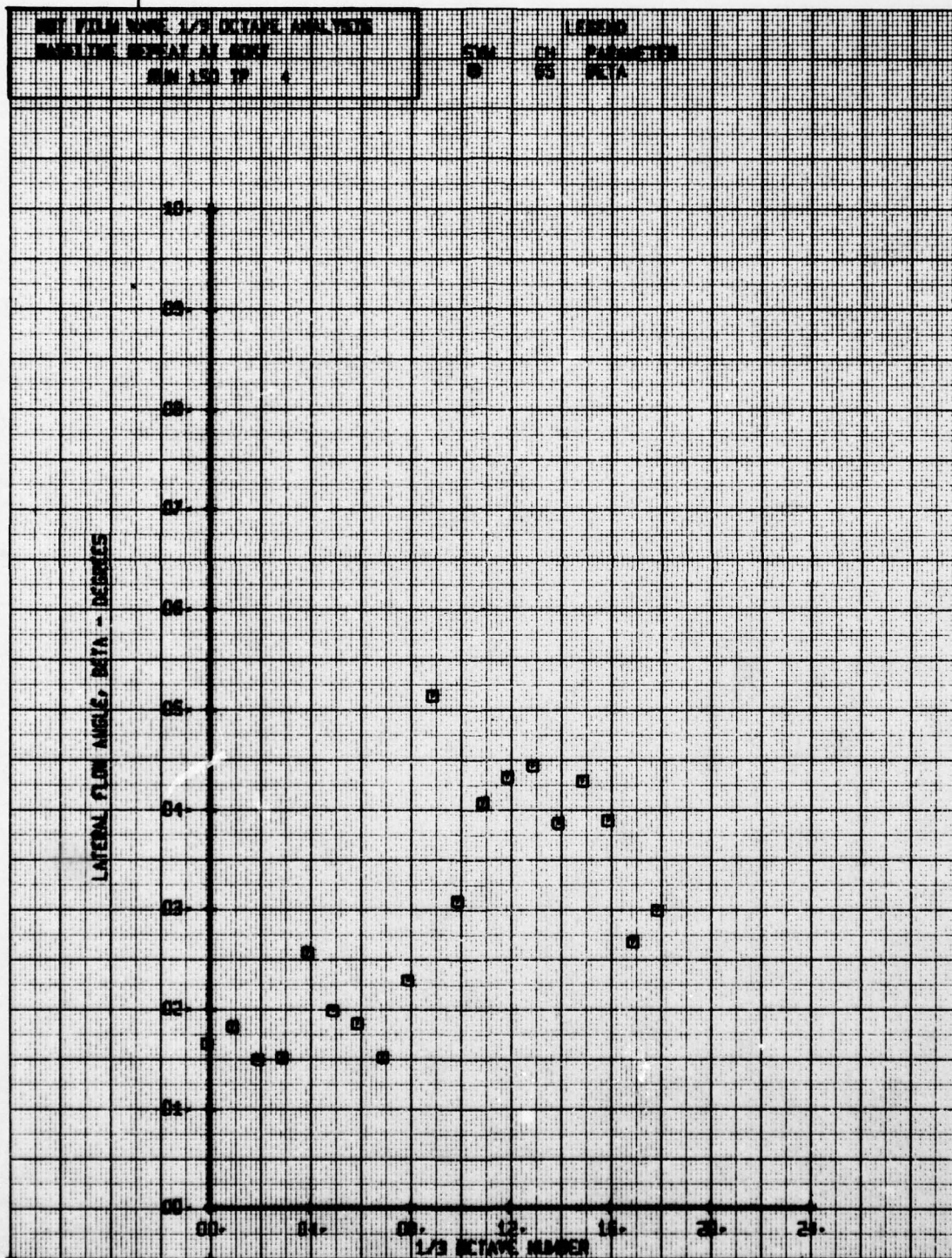


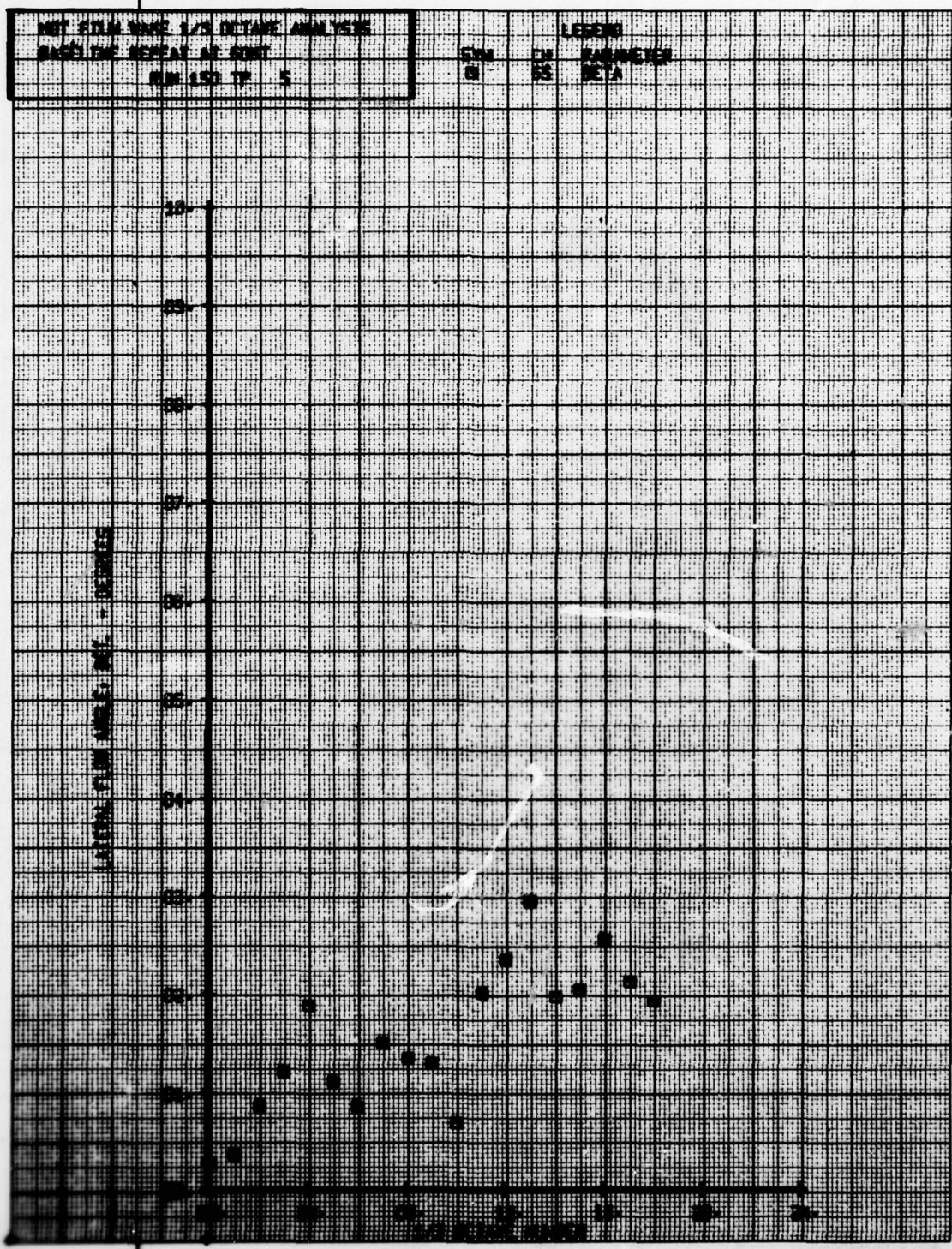










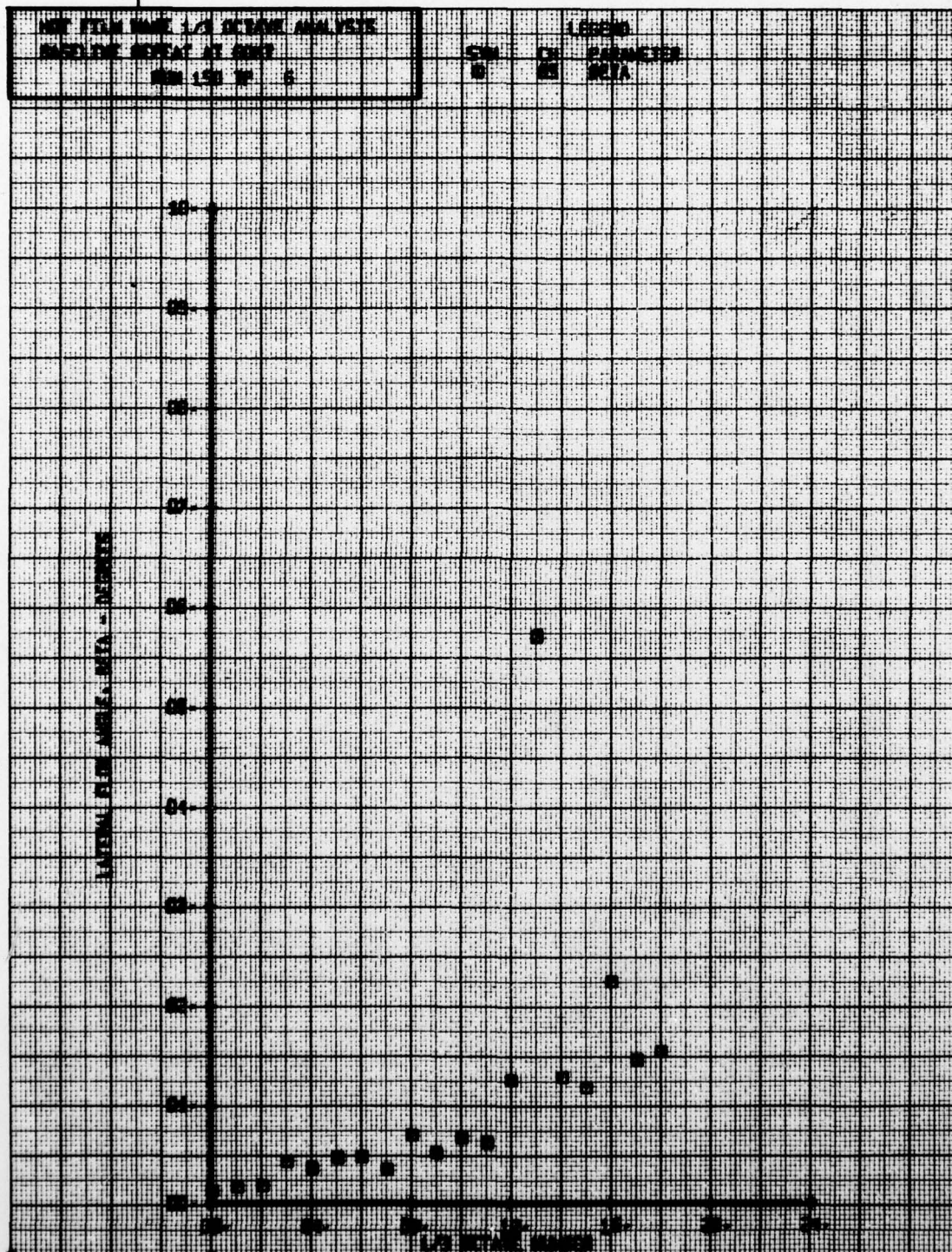


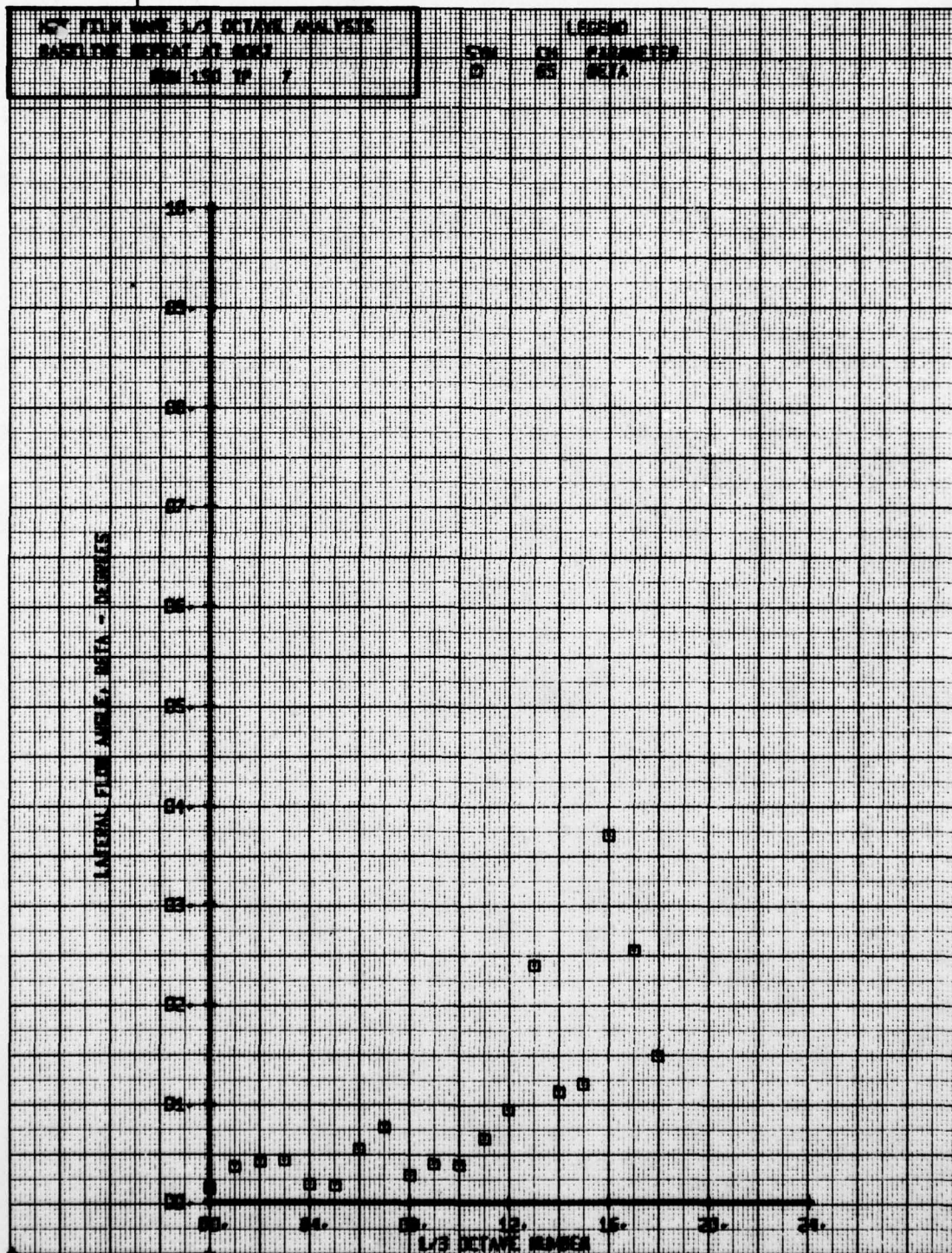


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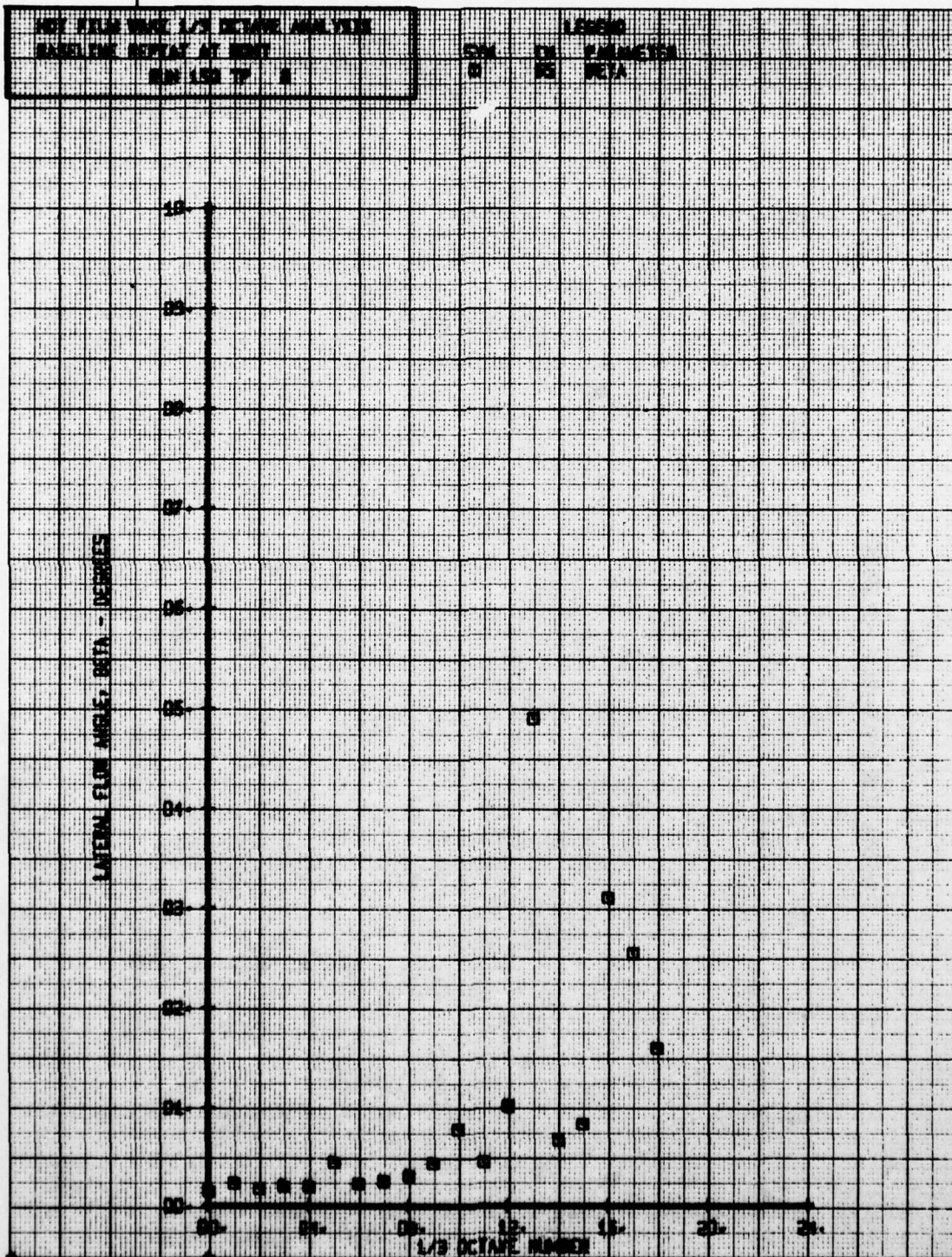
**CHICAGO**

**RE: [redacted]**









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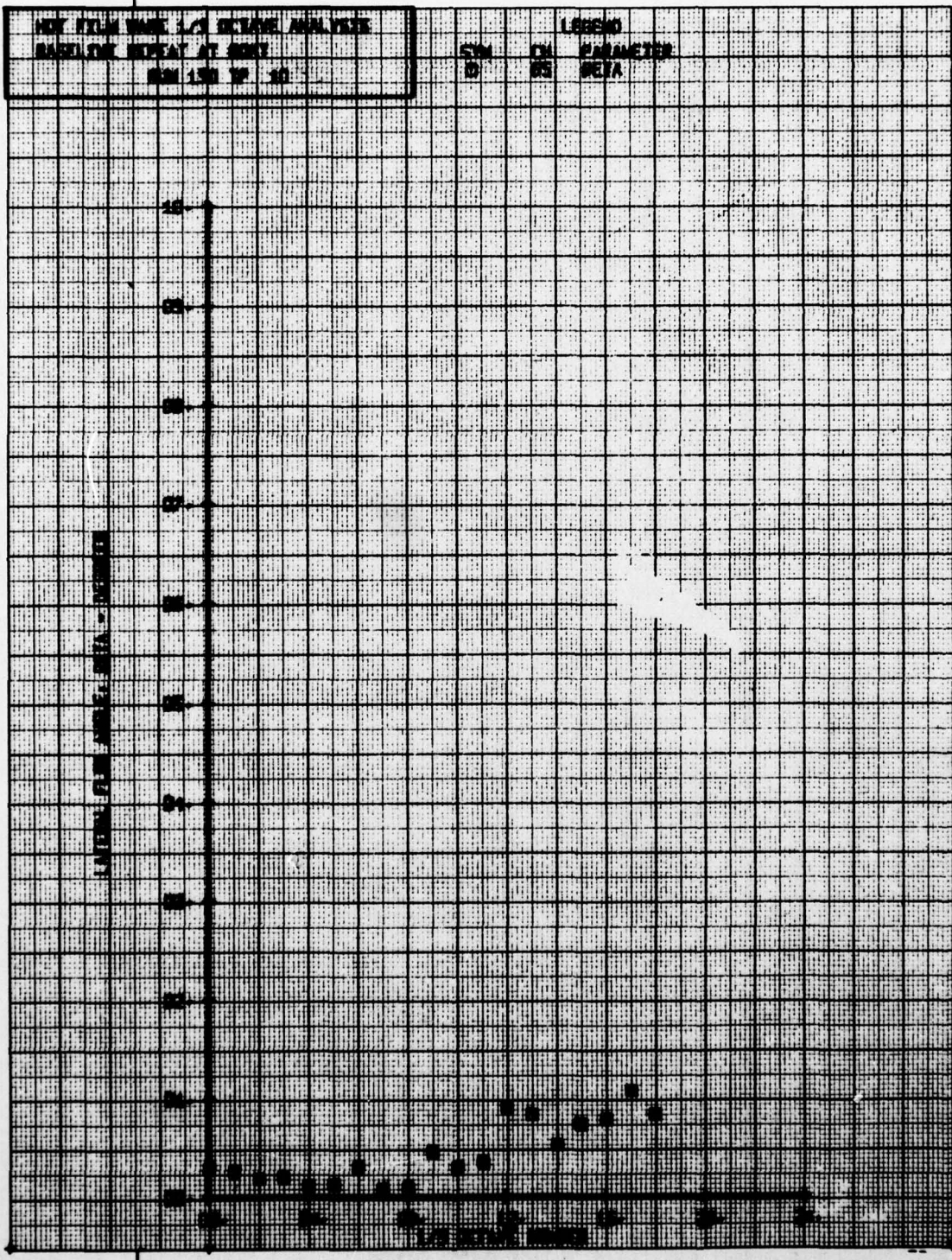
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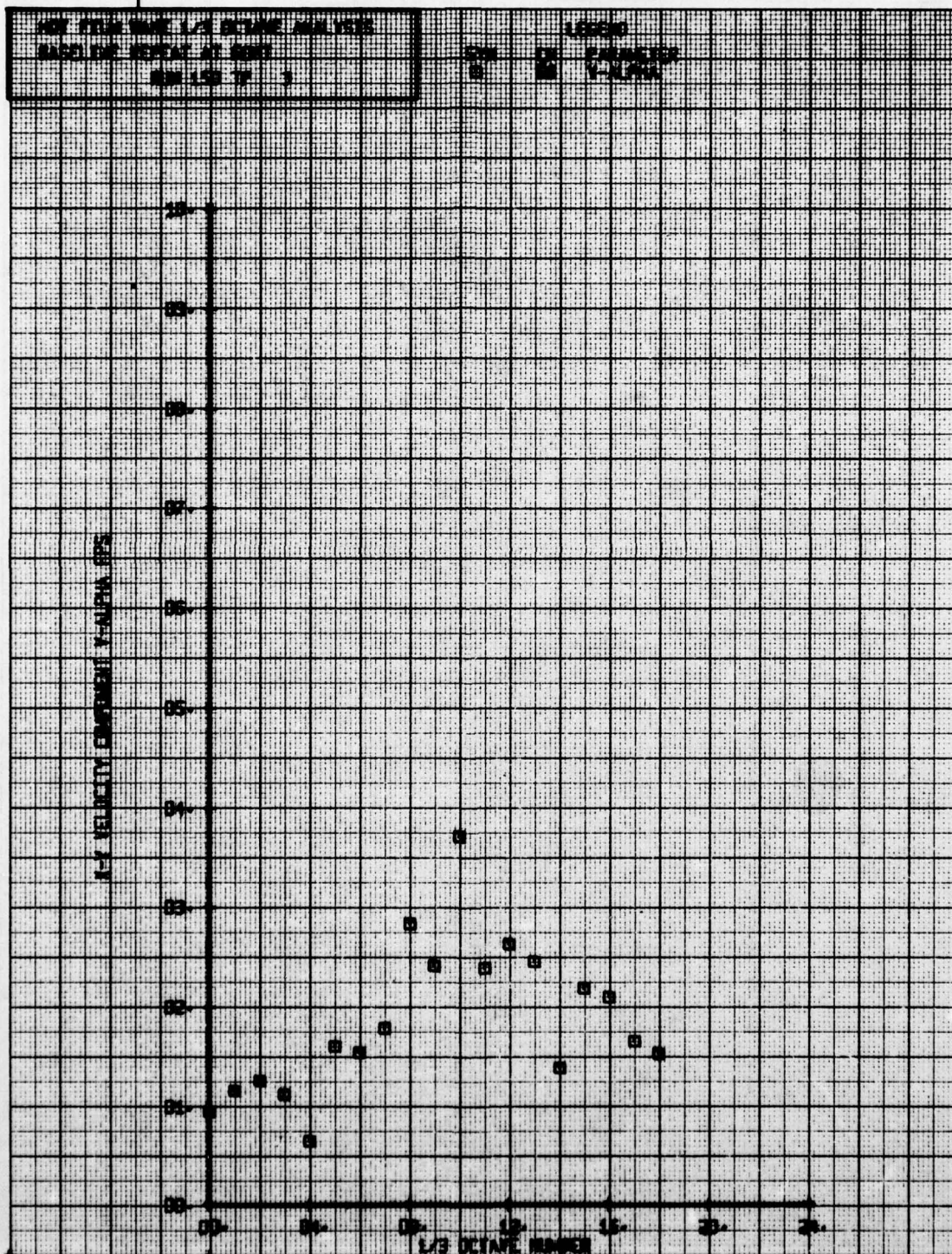
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 BASED ON POINT AT 800  
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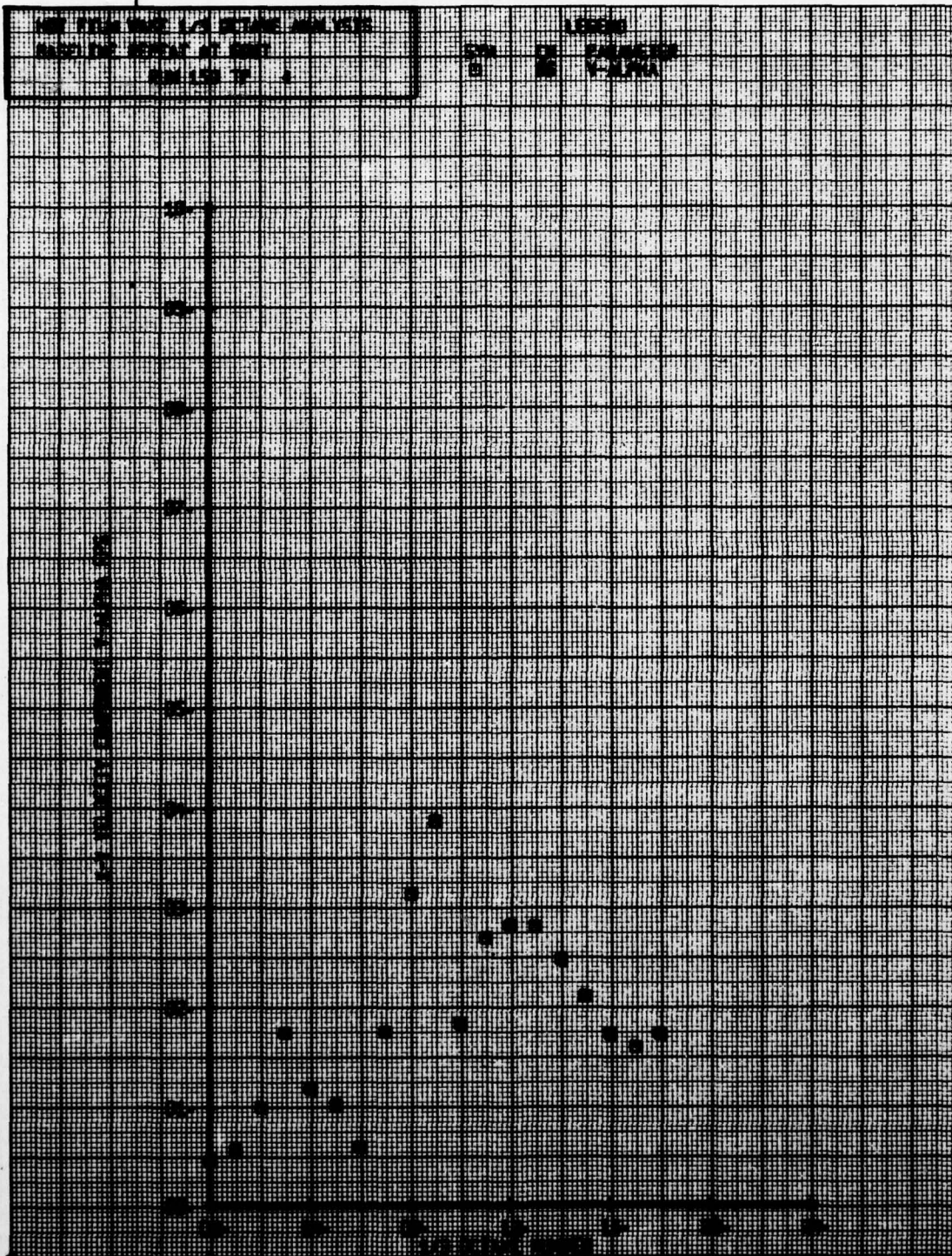
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1-2 VELOCITY CONSTANT Y-AXIS, CM

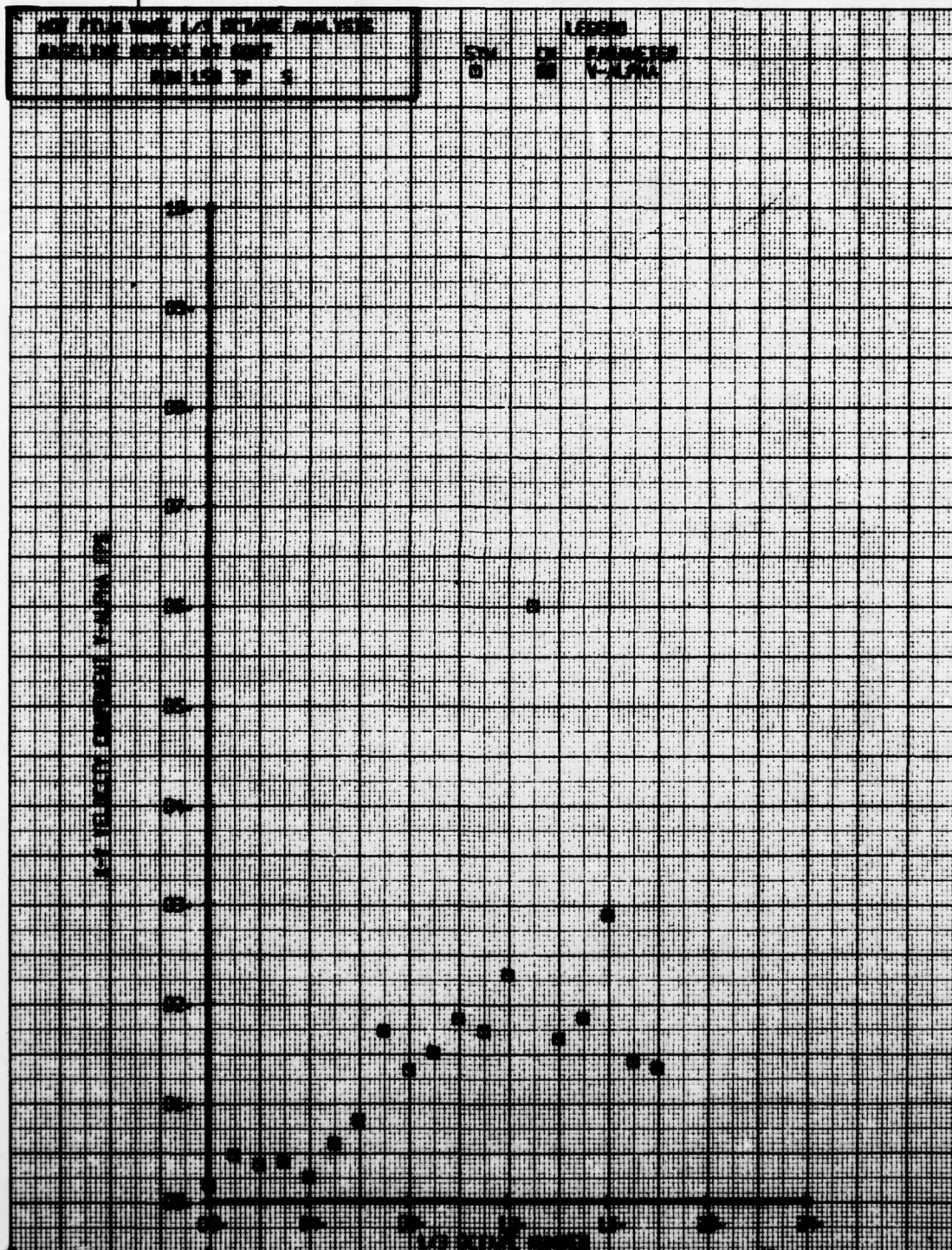
1-2 RETARD NUMBER

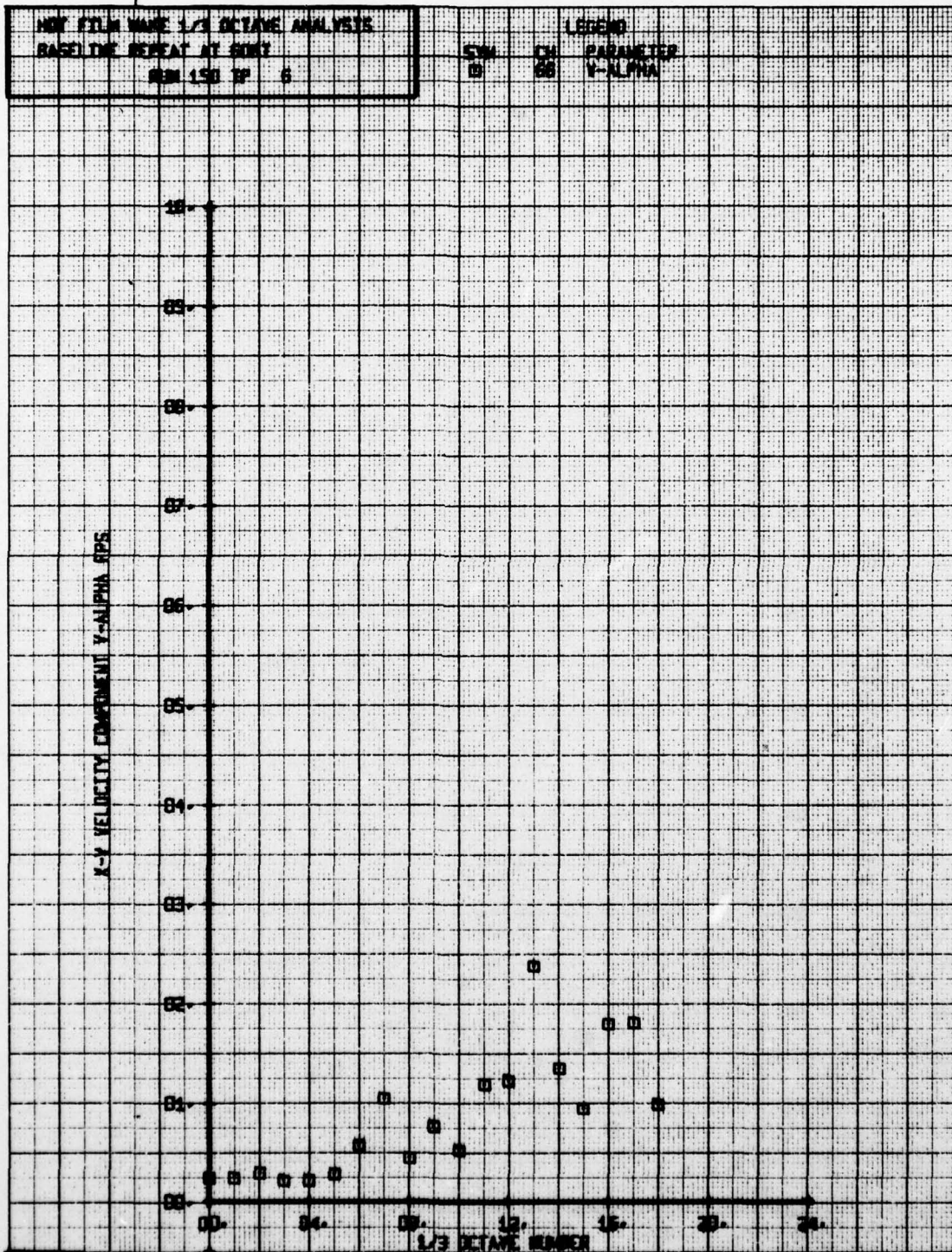




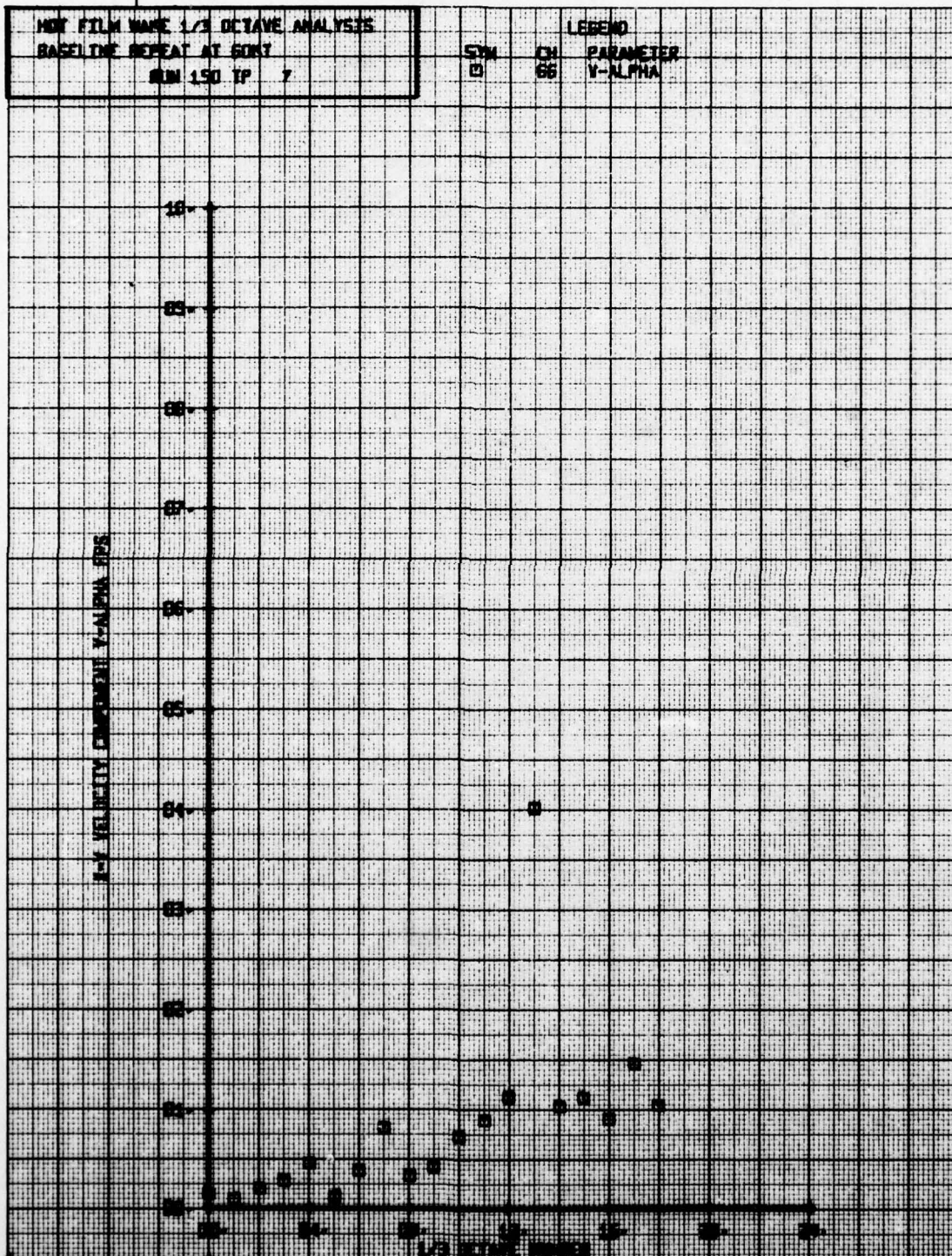


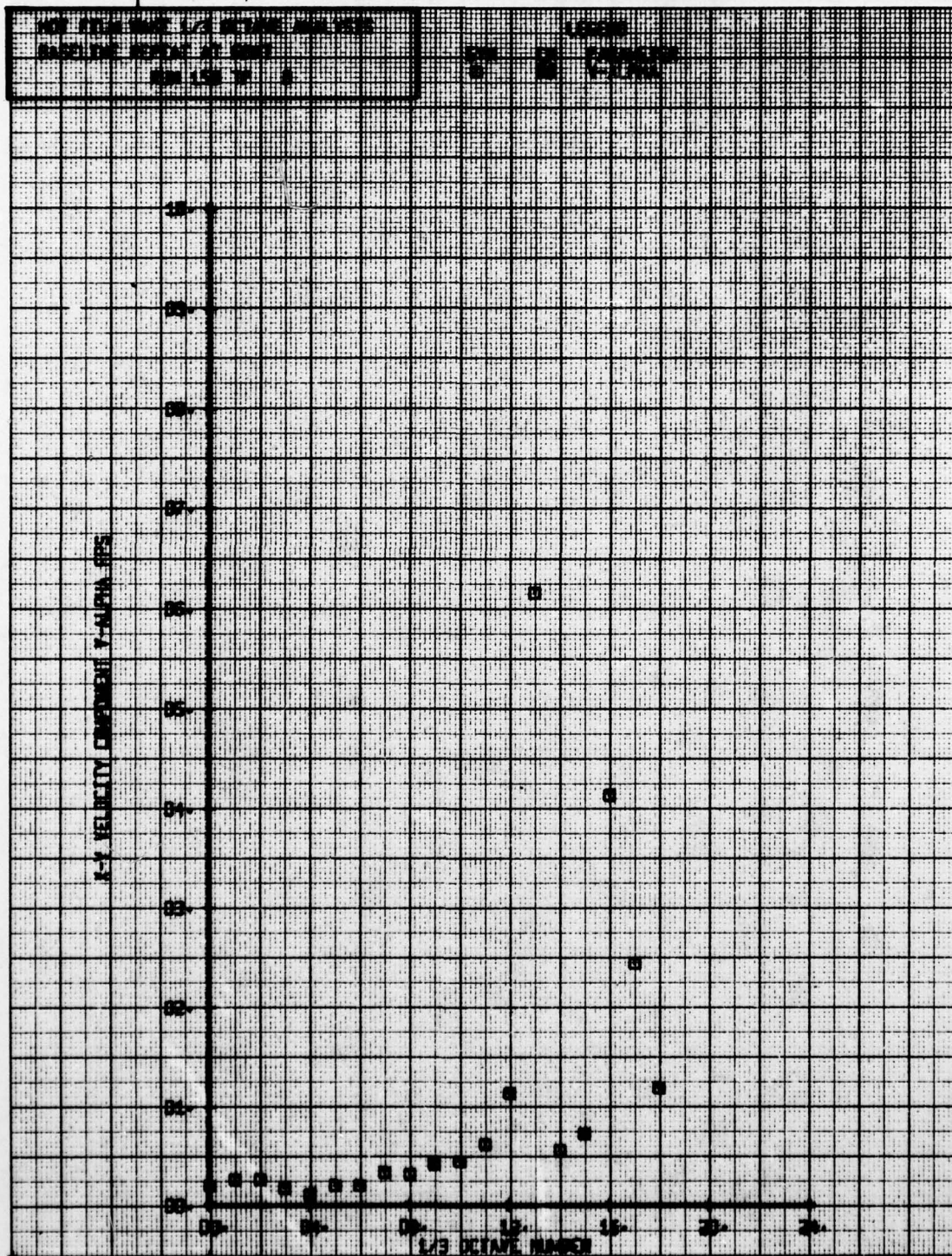






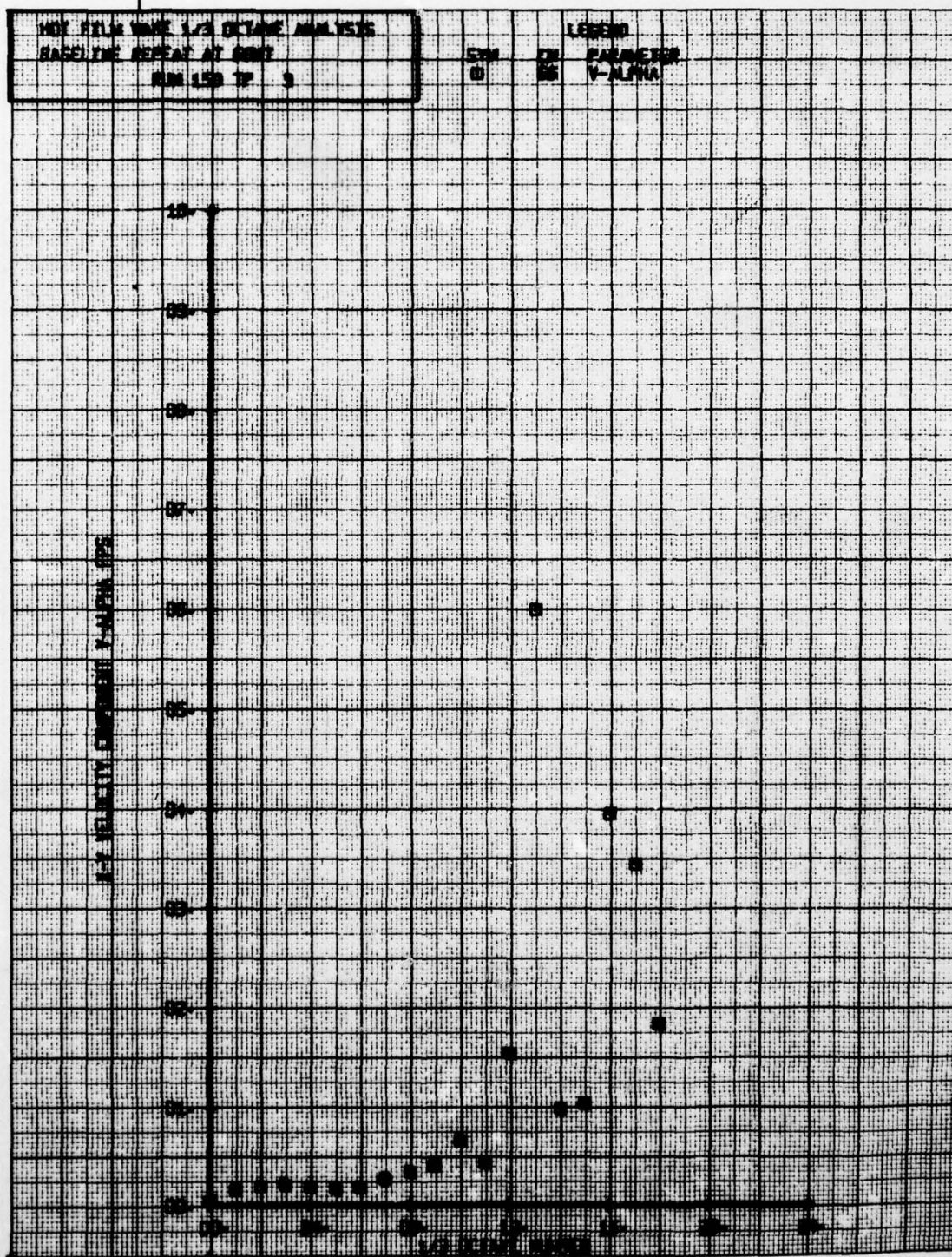








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F/G 1/3

INTERACTIONAL AERODYNAMICS OF THE SINGLE ROTOR HELICOPTER CONF--ETC(U)

SEP 78 P F SHERIDAN

DAAJ02-77-C-0020

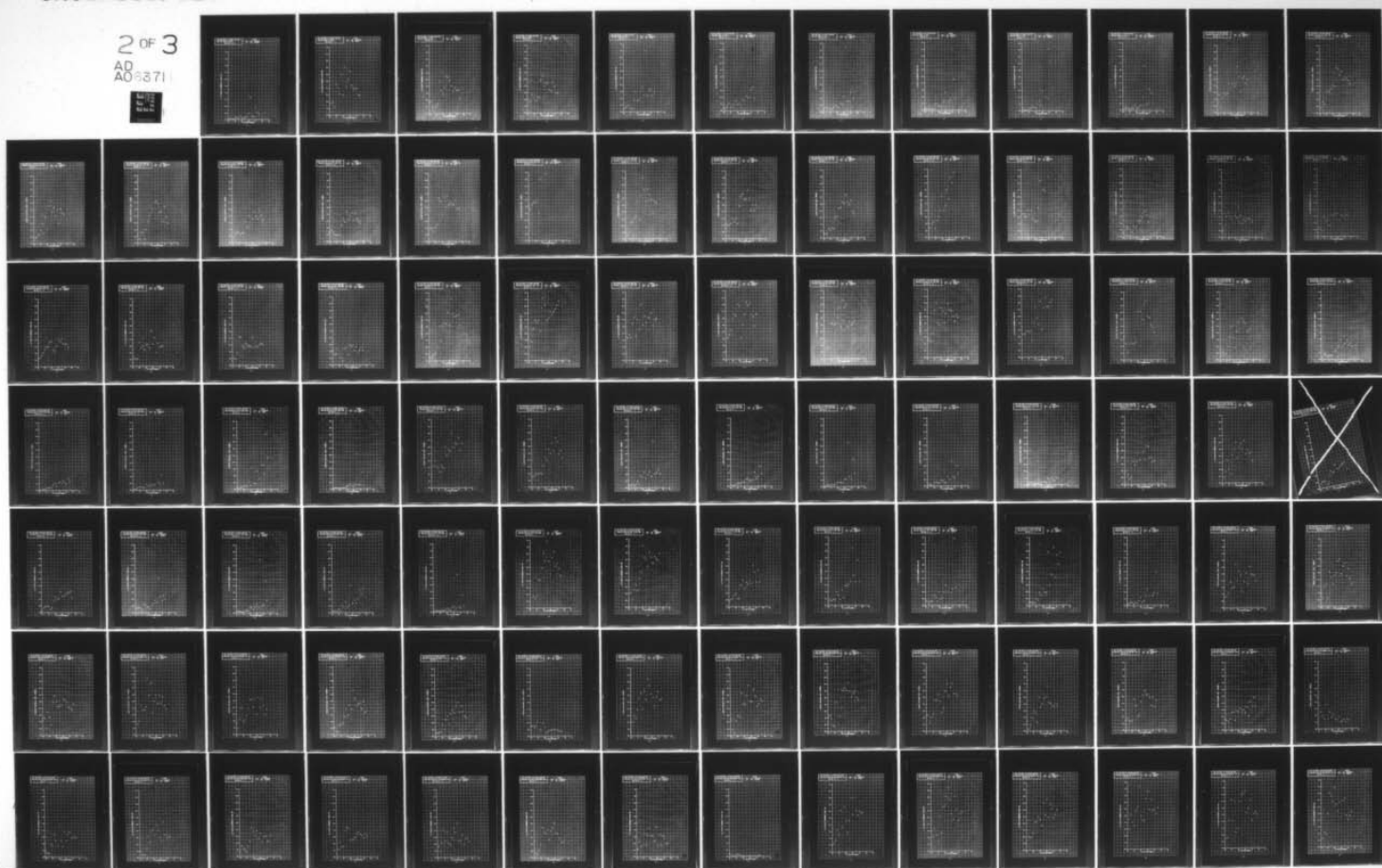
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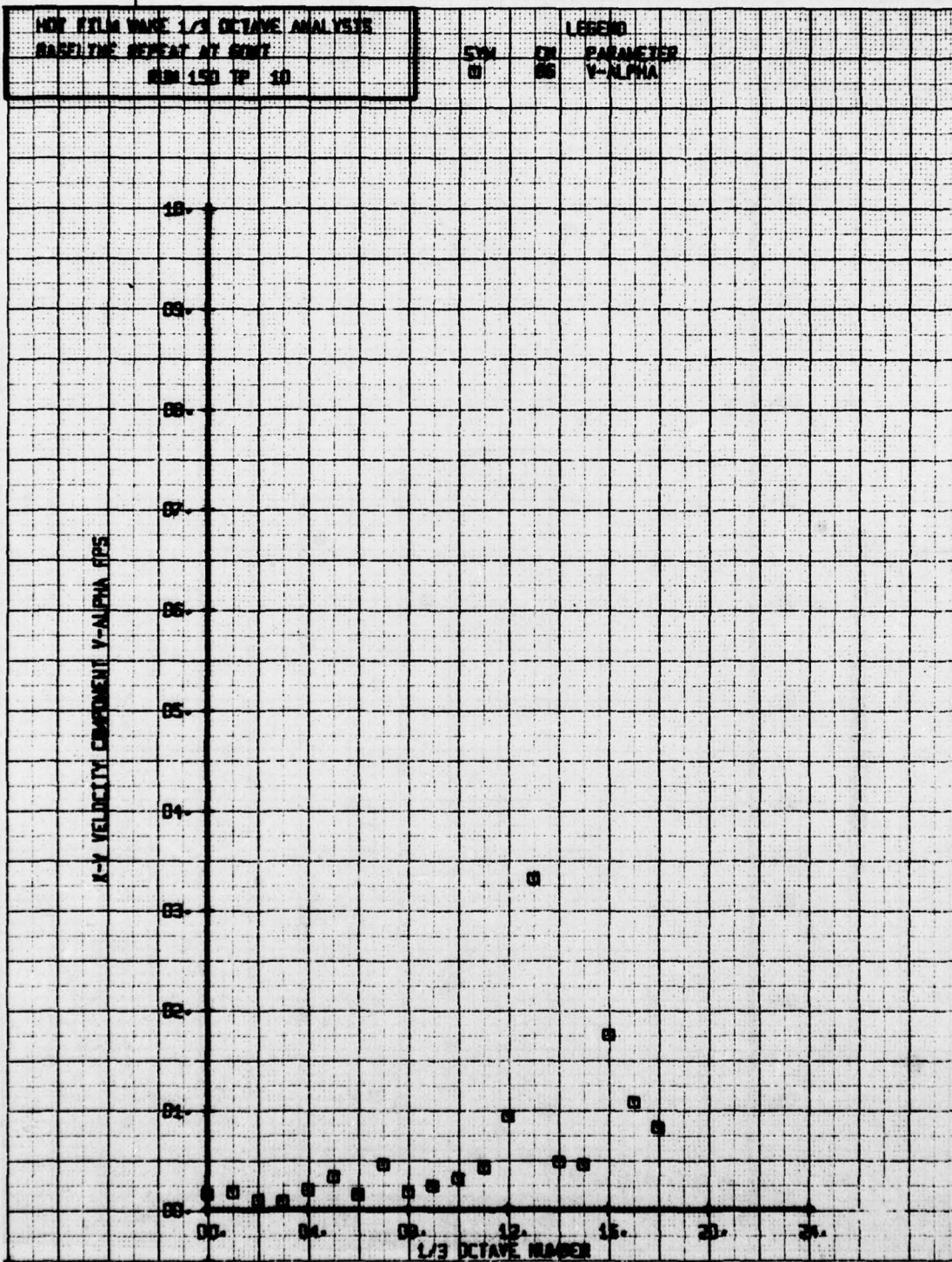
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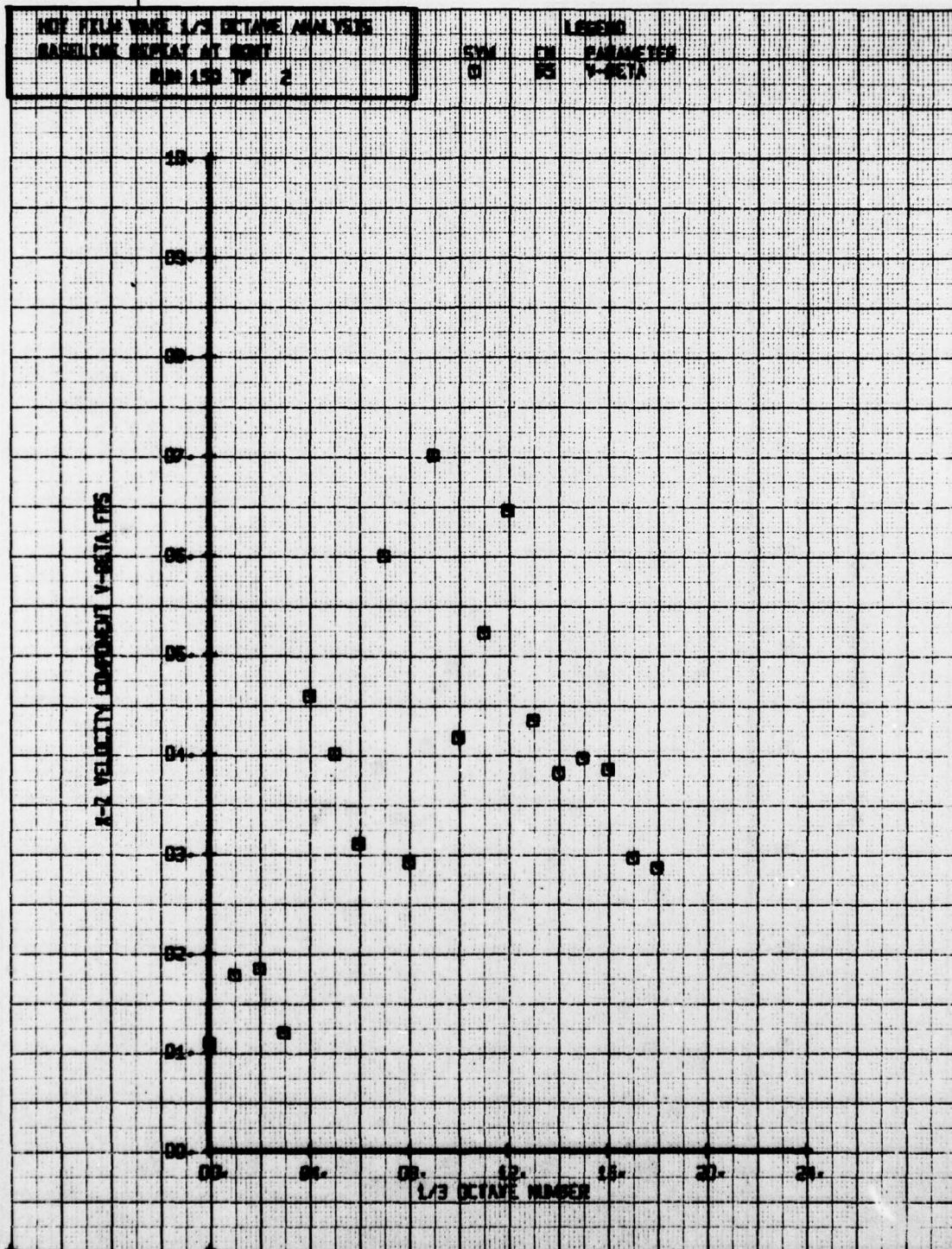
2 OF 3

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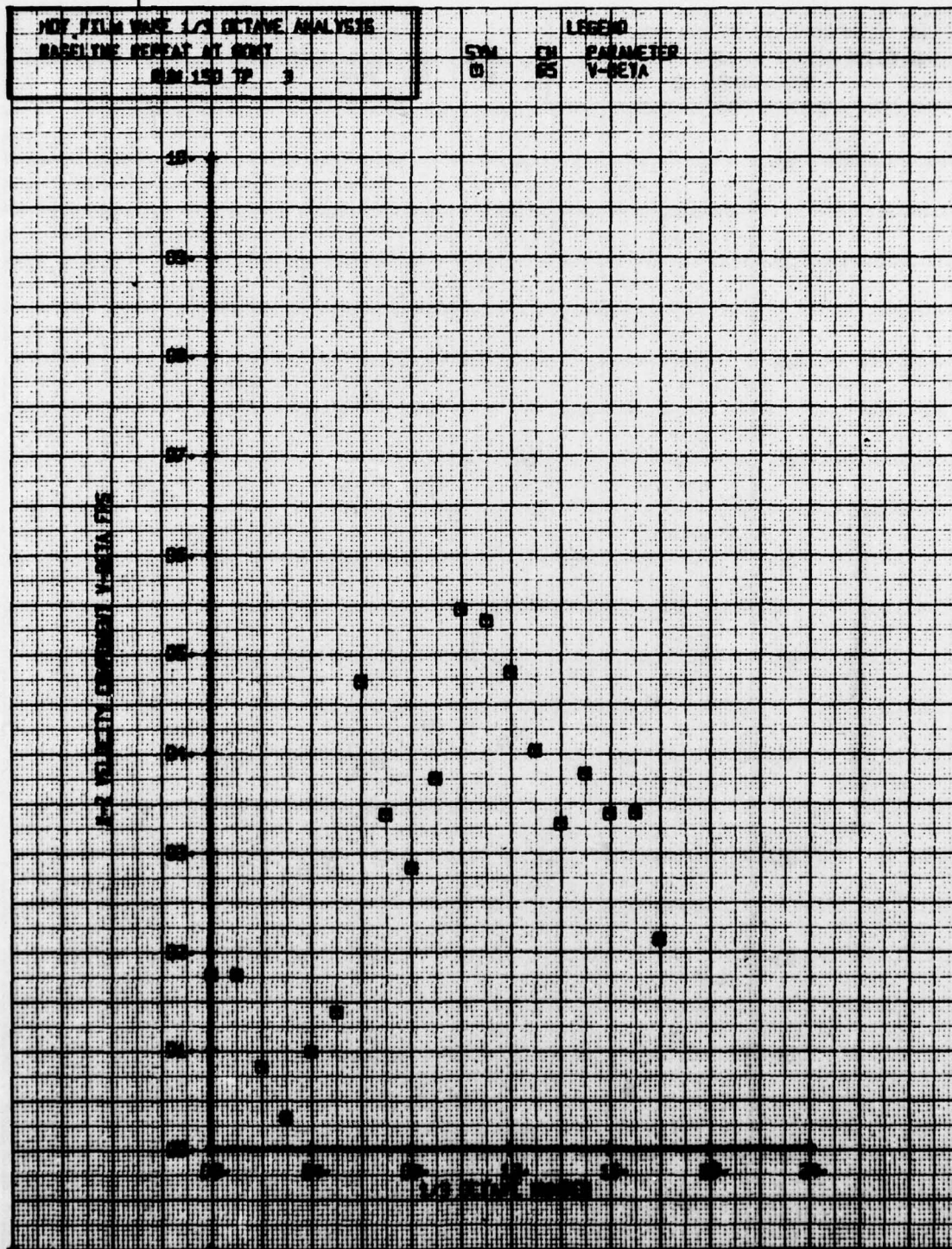


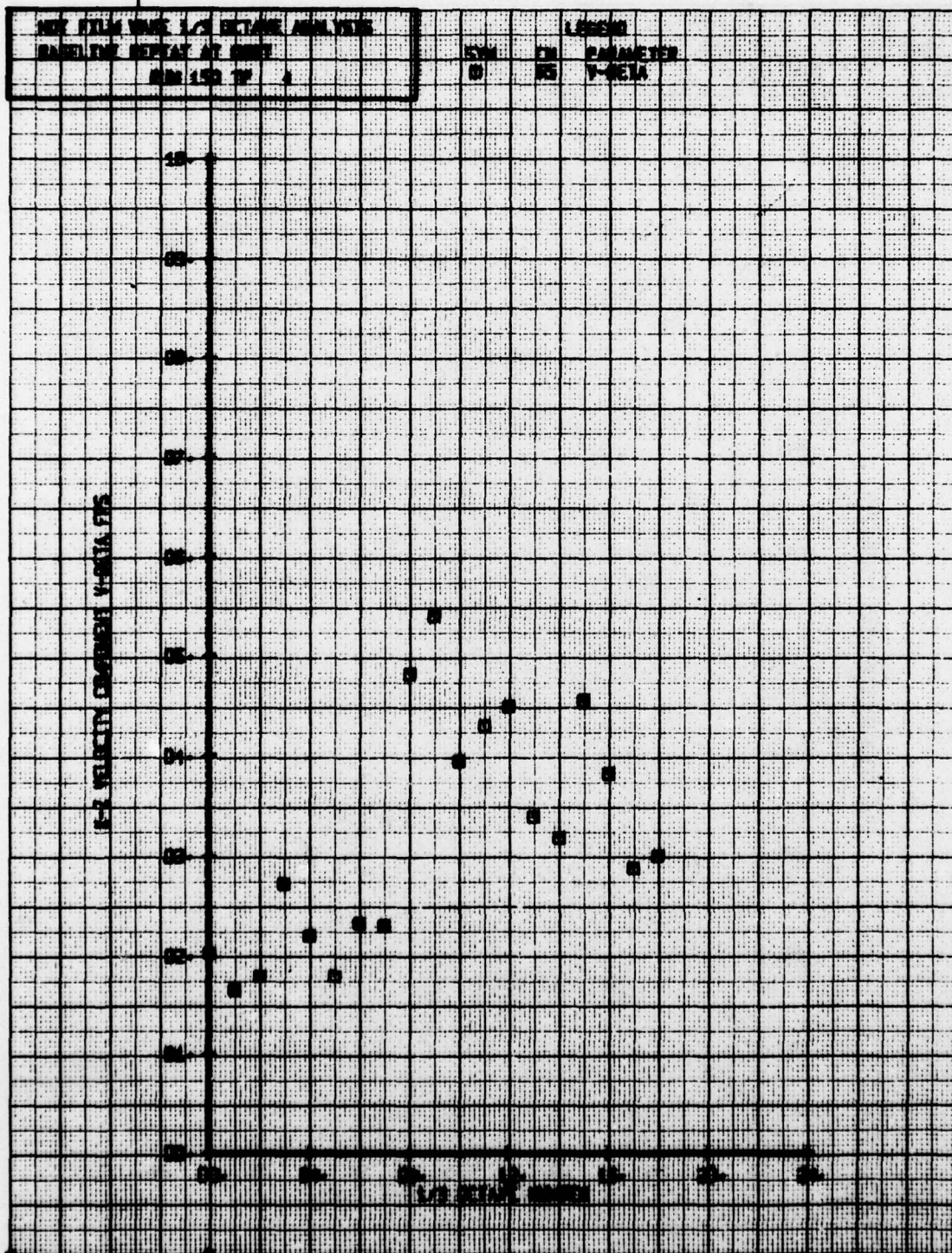




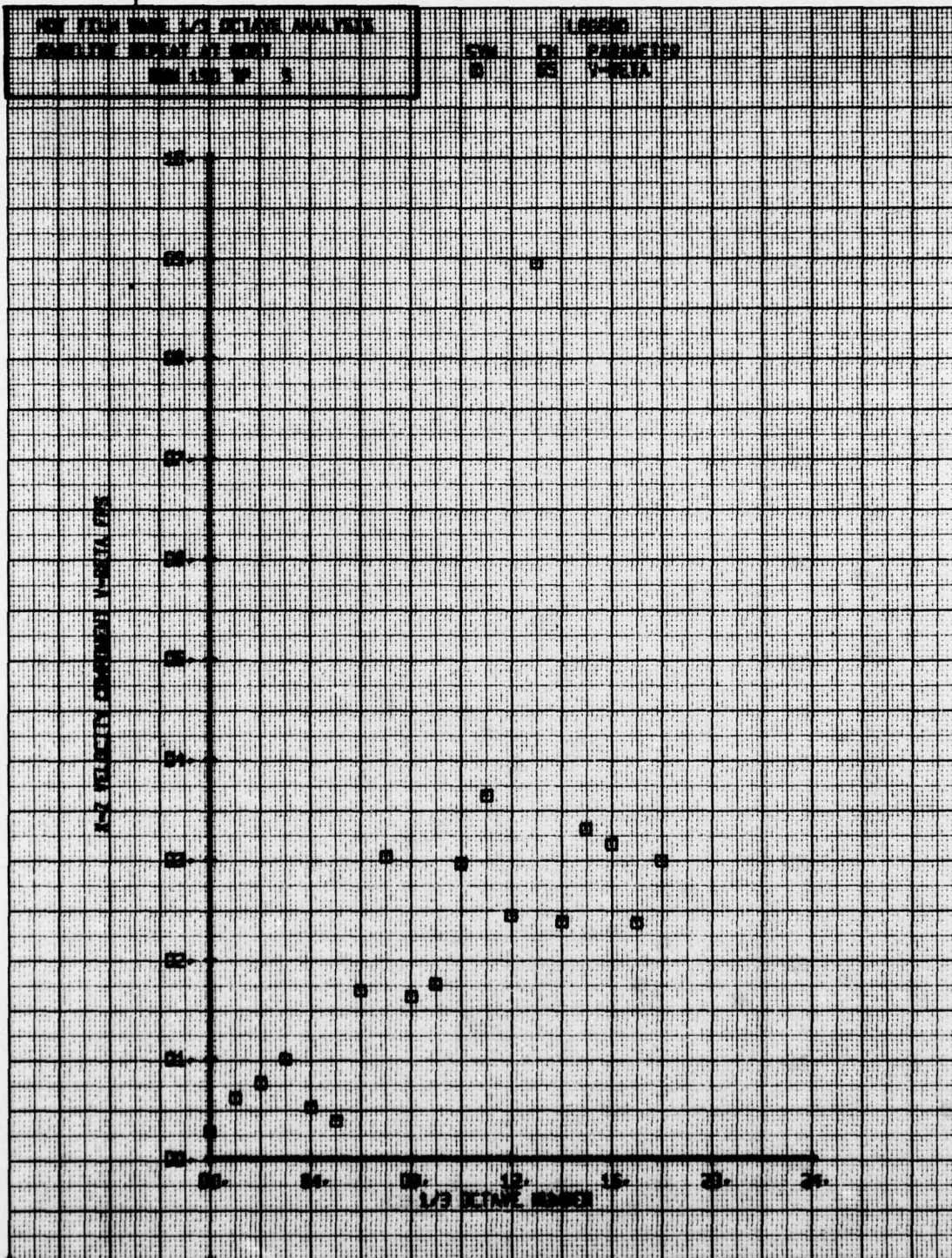
NOV FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE REPEAT AT 800T  
 MIN 150 TP 3

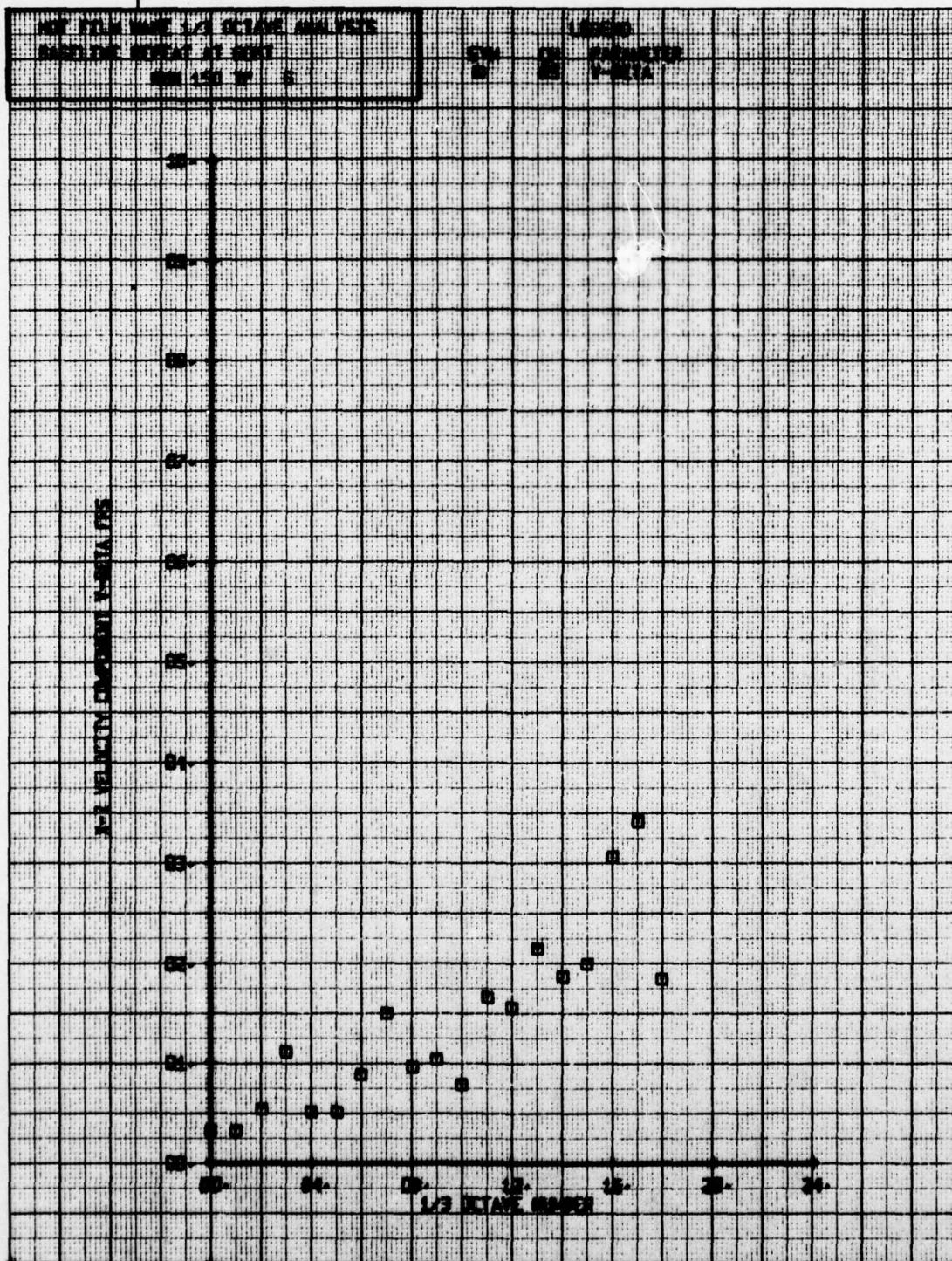
SYM CH PARAMETER  
 ( ) 05 V-DETA



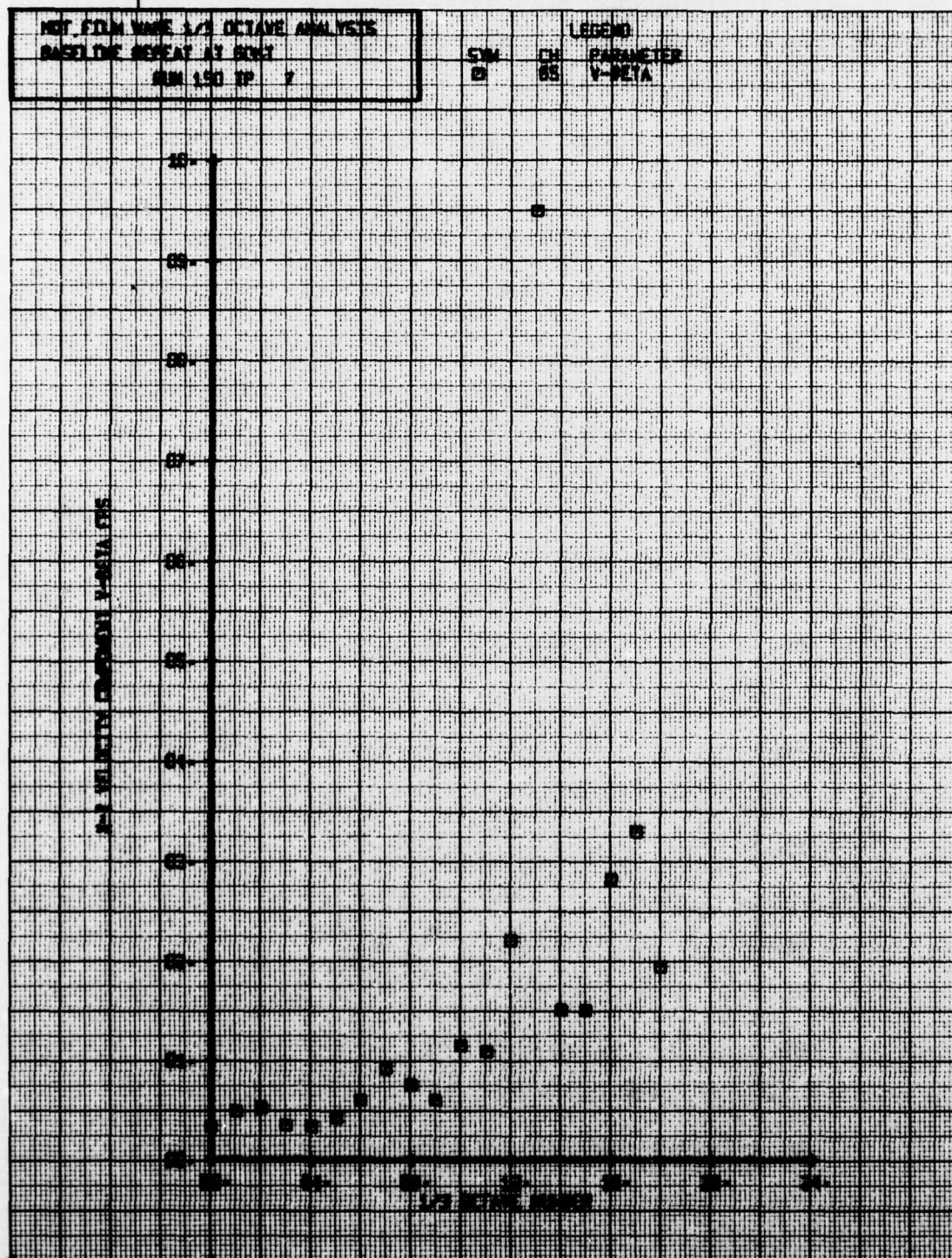


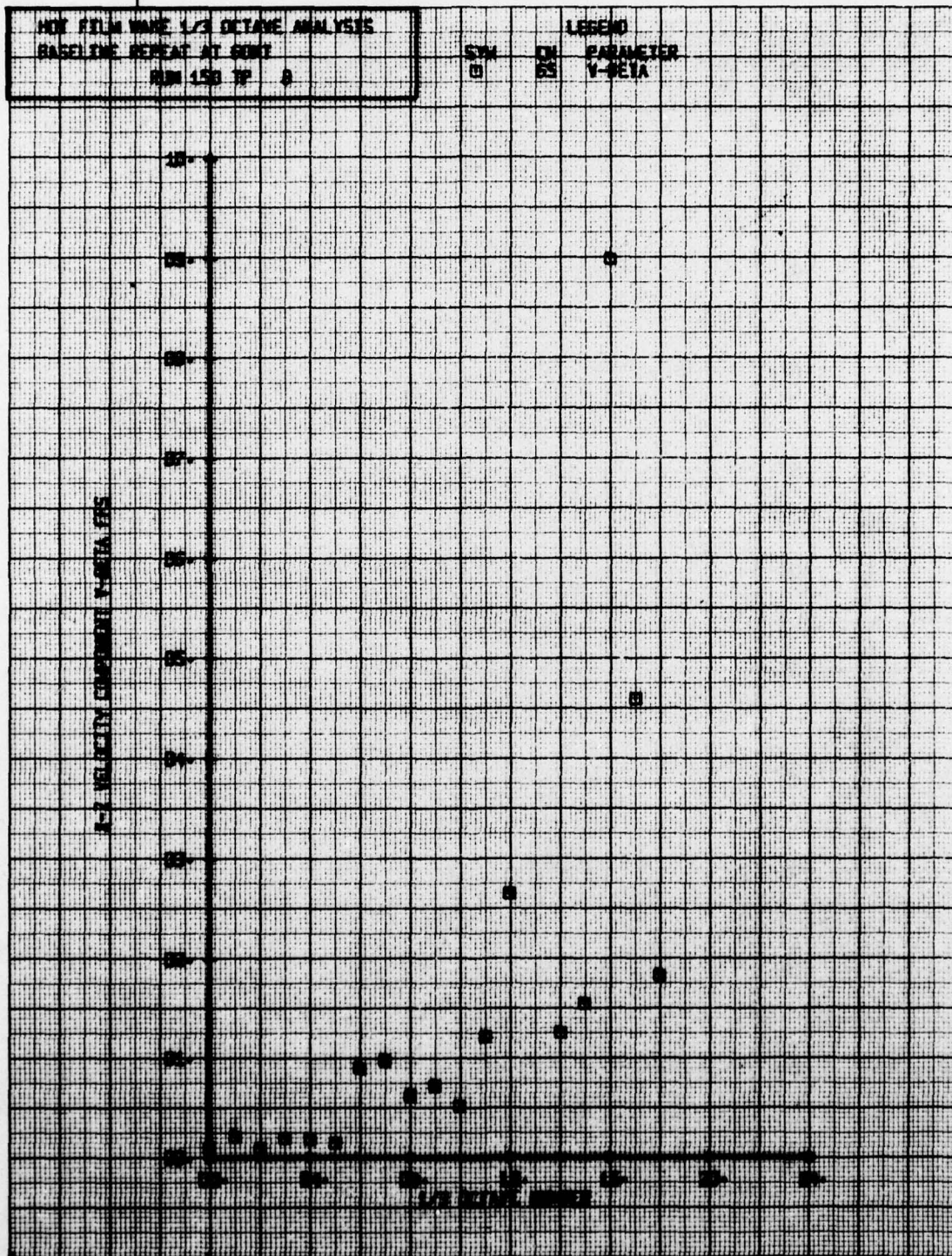




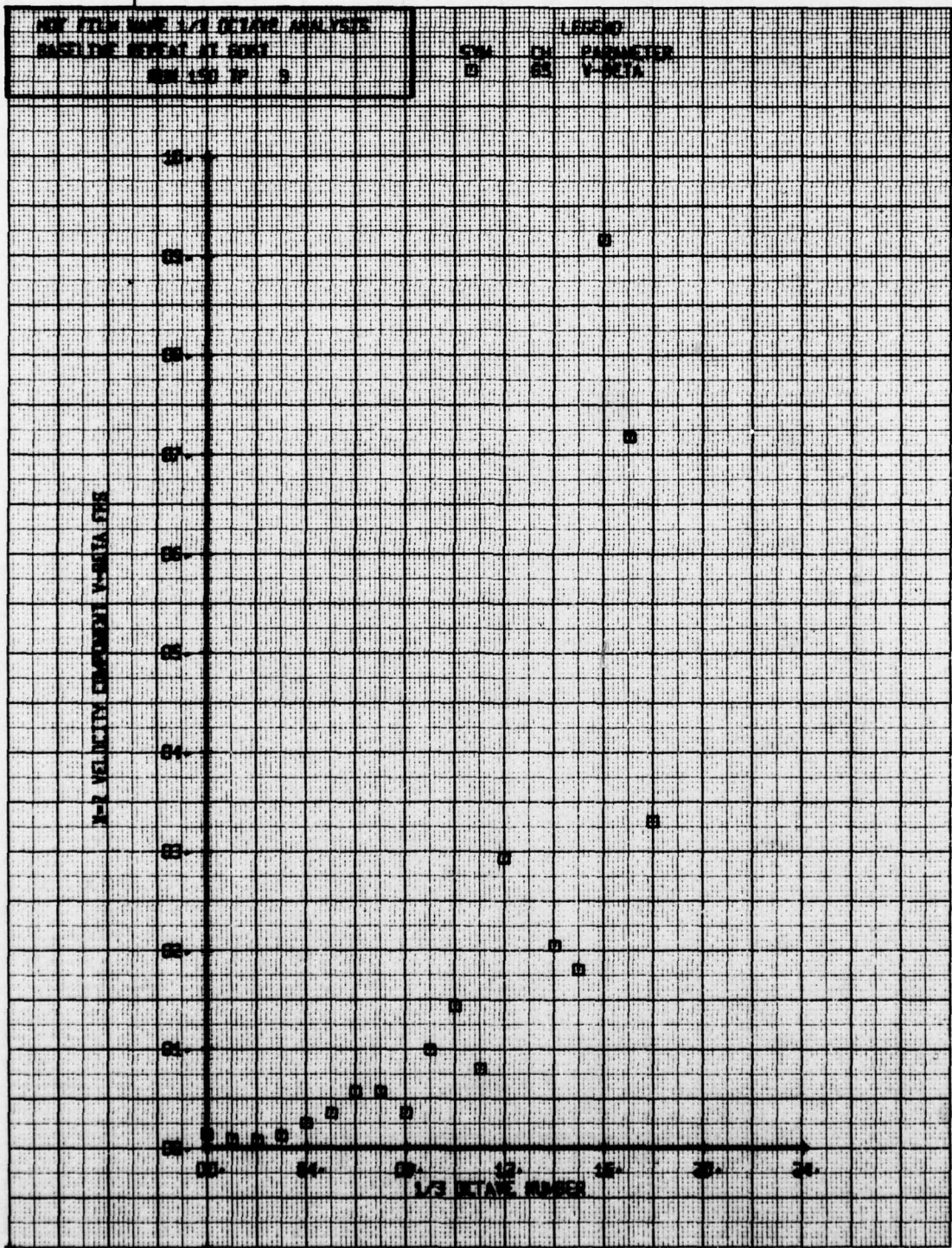


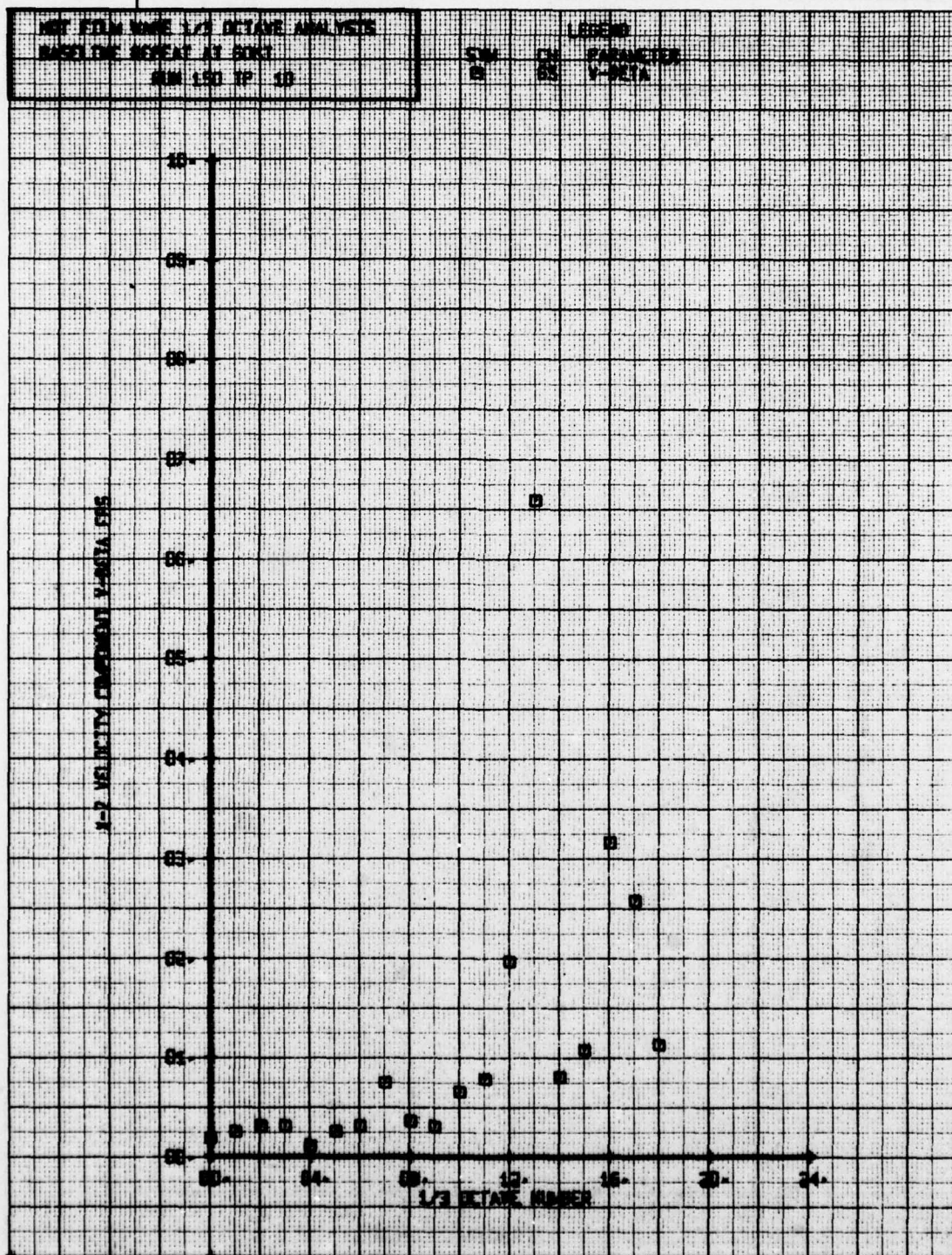














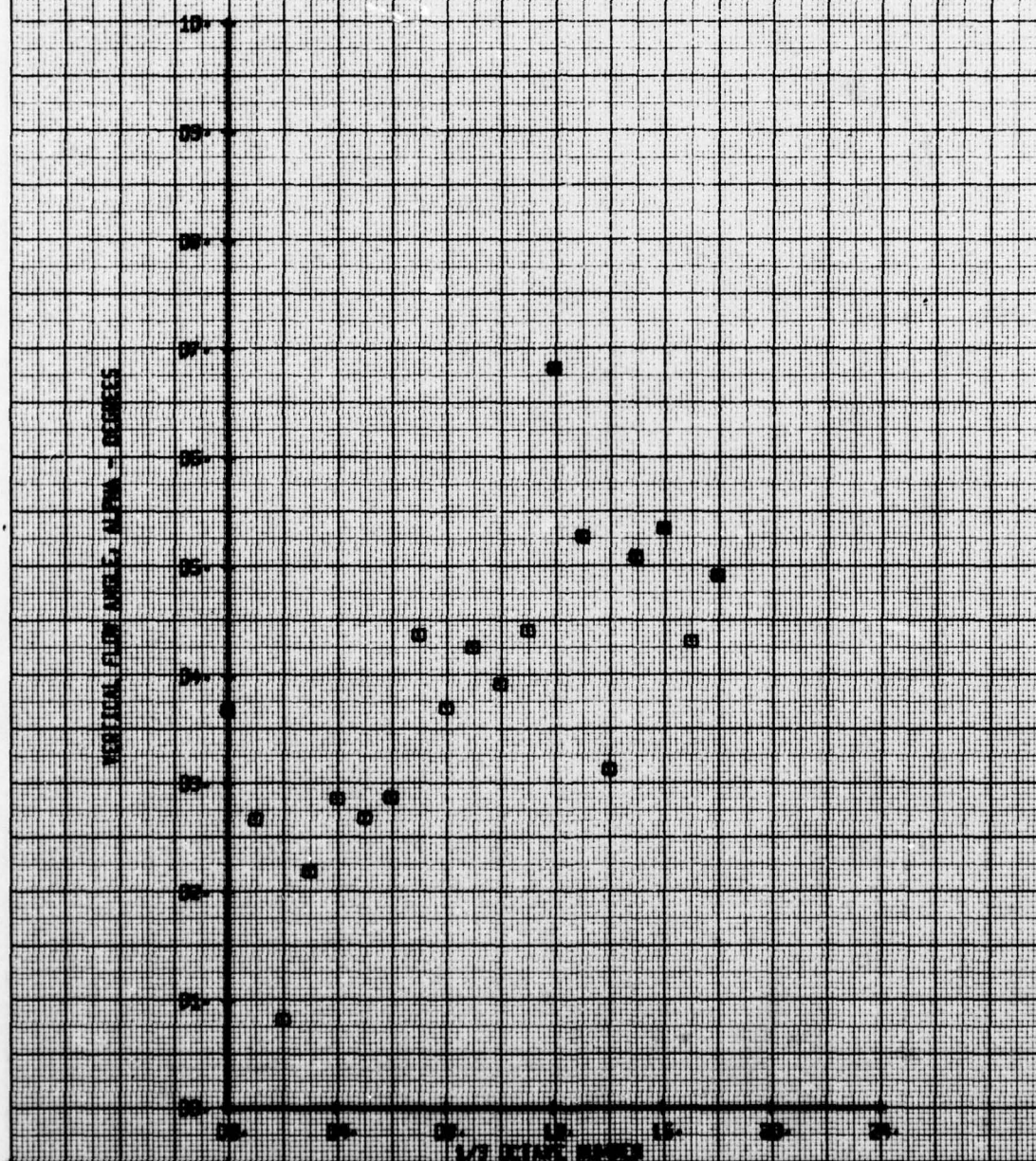
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 BASELINE 8-10-64 BLADES OFF, ROT. HUB  
 RUN 150 TP 5

SYM  
 CH

LEGEND

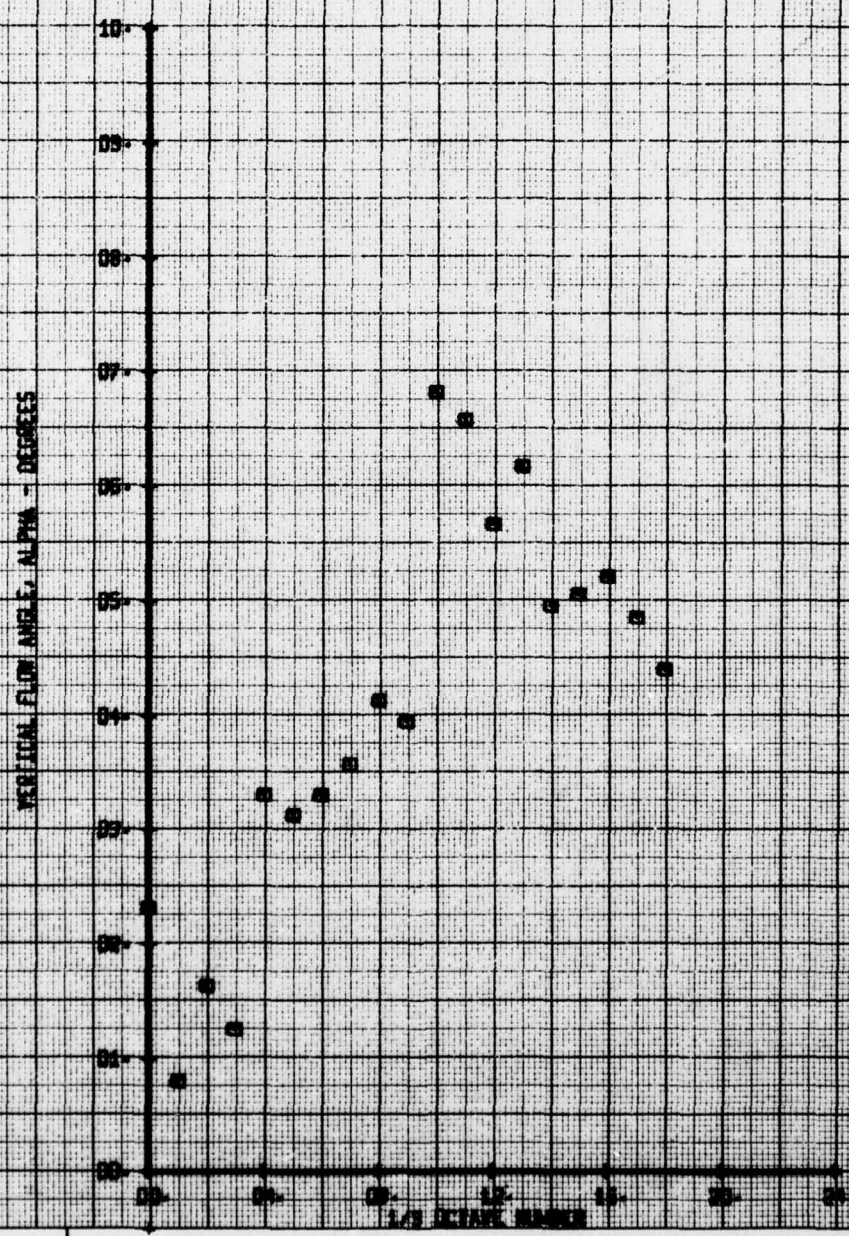
CH  
 56  
 PARAMETER  
 ALPHA

VERTICAL FLUID ANGLE, ALPHA - DEGREES



HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE 8-11 BLADES OFF, RET. HUB  
 RUN 150 TP 6

SYN CH  
 01 55  
 LEGEND  
 PARAMETER  
 ALPHA



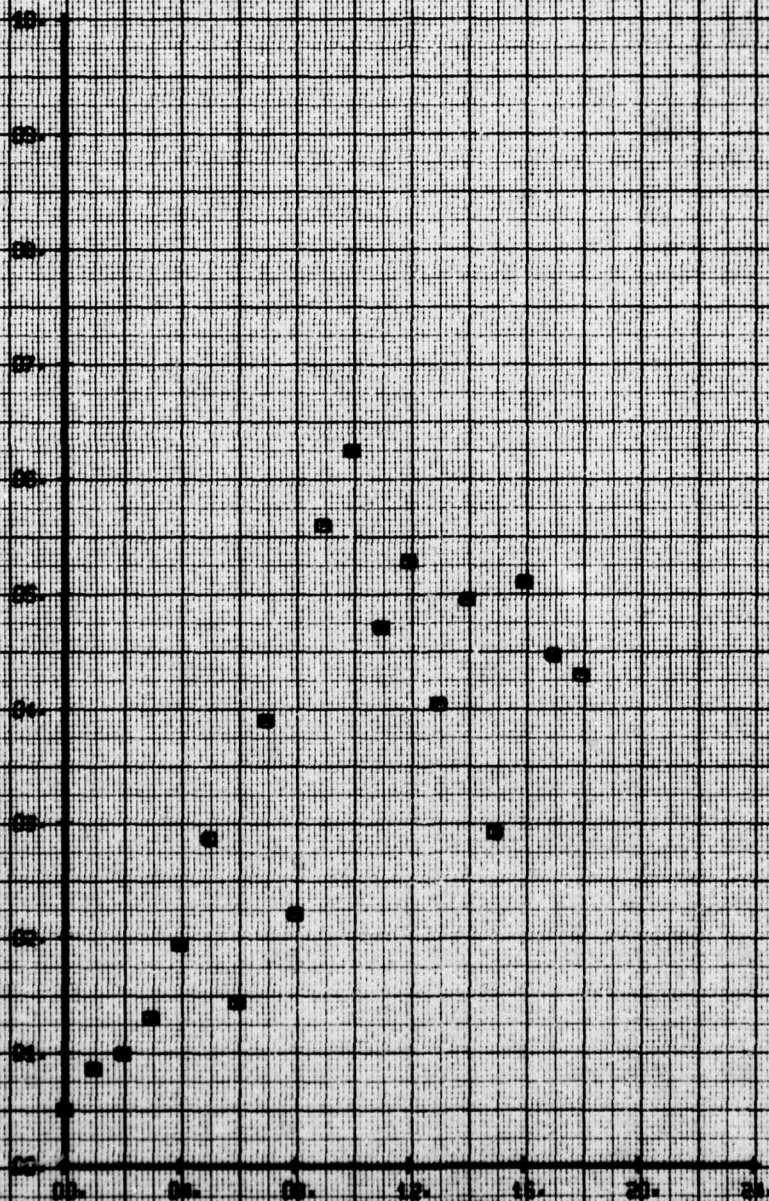


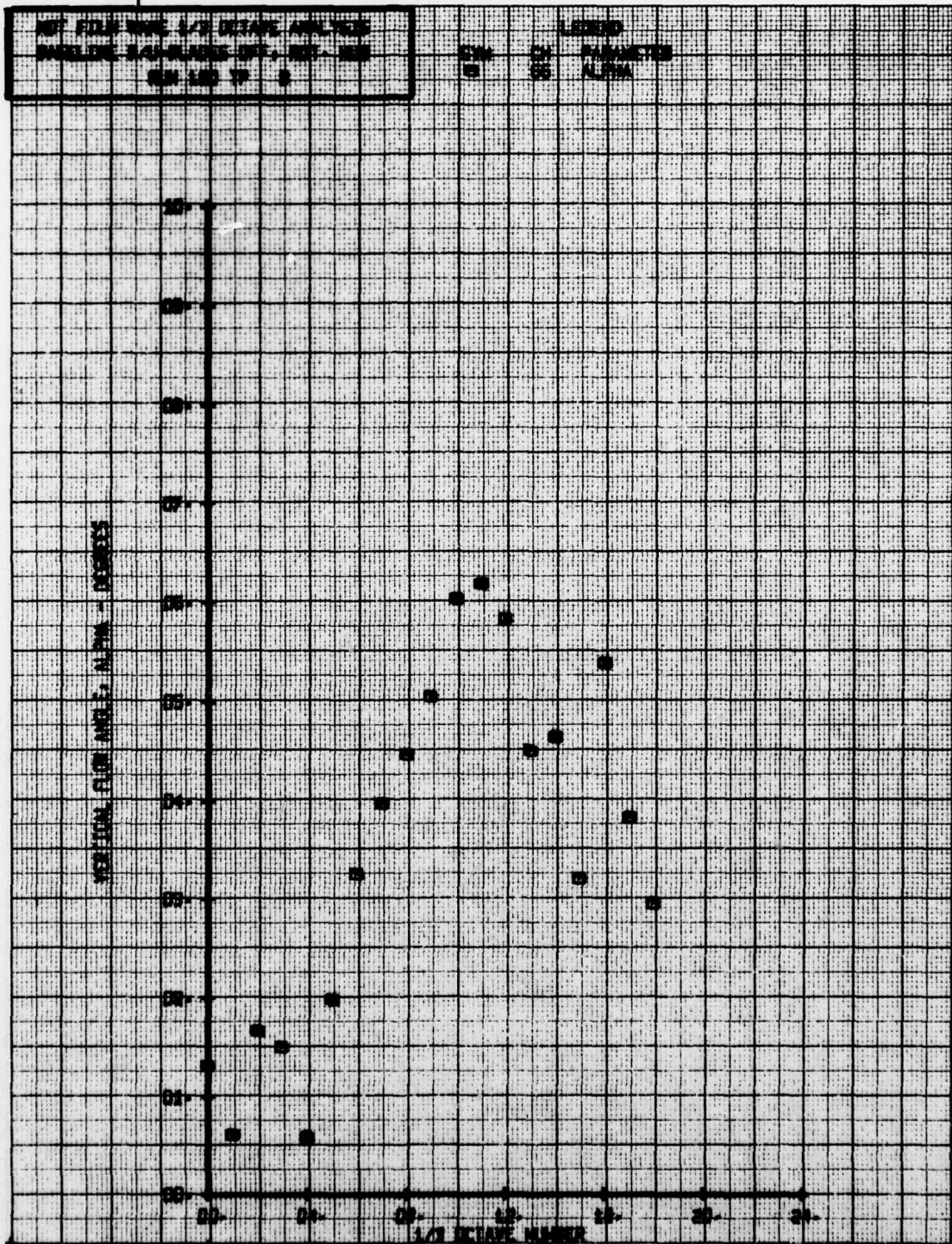
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 HORIZONTAL FLUX ANGLE, ALPHA, DEGREES  
 RUN NO. 12 7

LEGEND  
 C100 ON  
 100 OFF  
 ALPHA

HORIZONTAL FLUX ANGLE, ALPHA - DEGREES

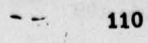
1/3 OCTAVE NUMBER





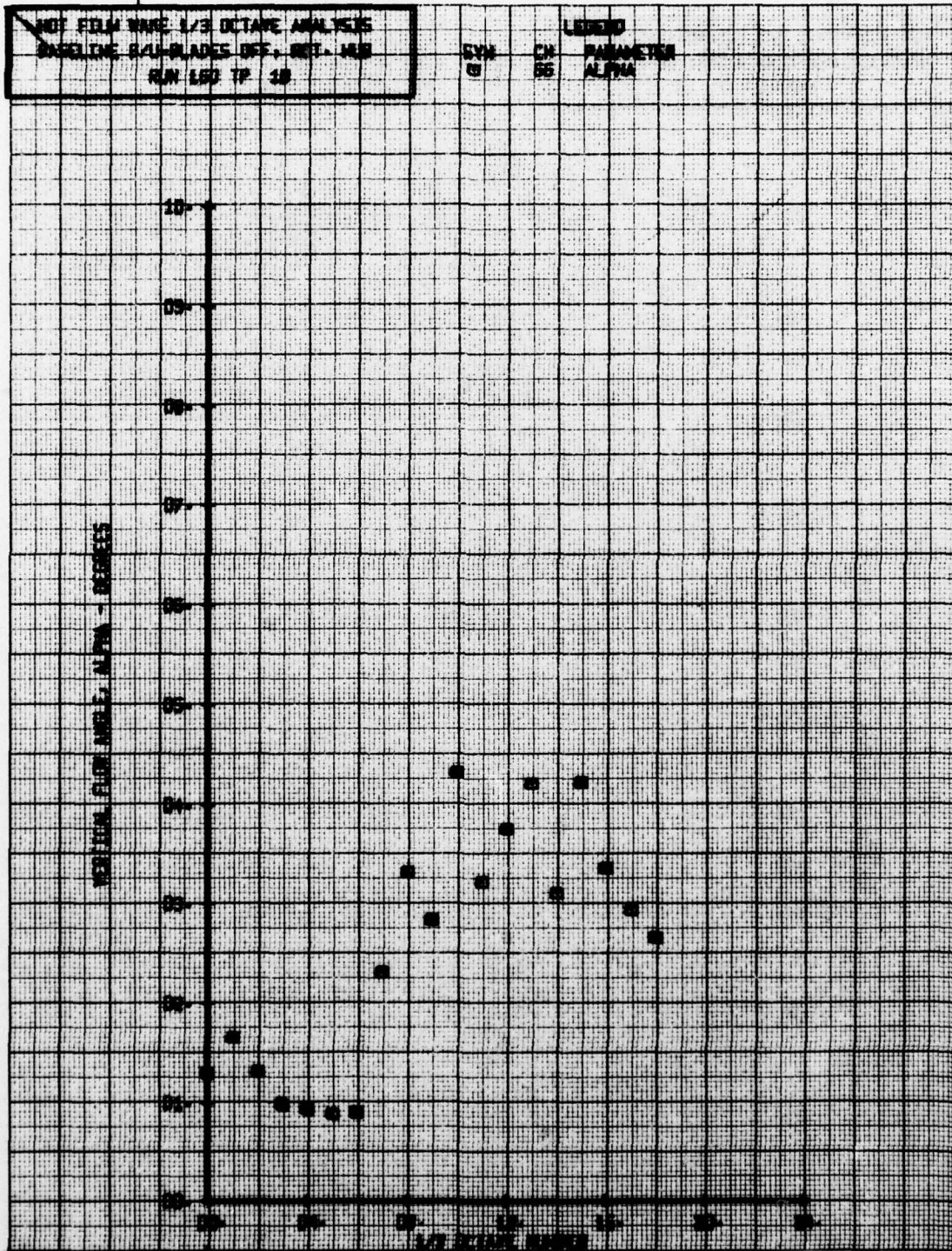


DATA	DATE	LOCATION
01	01	PARAMETER
02	02	ALPHA



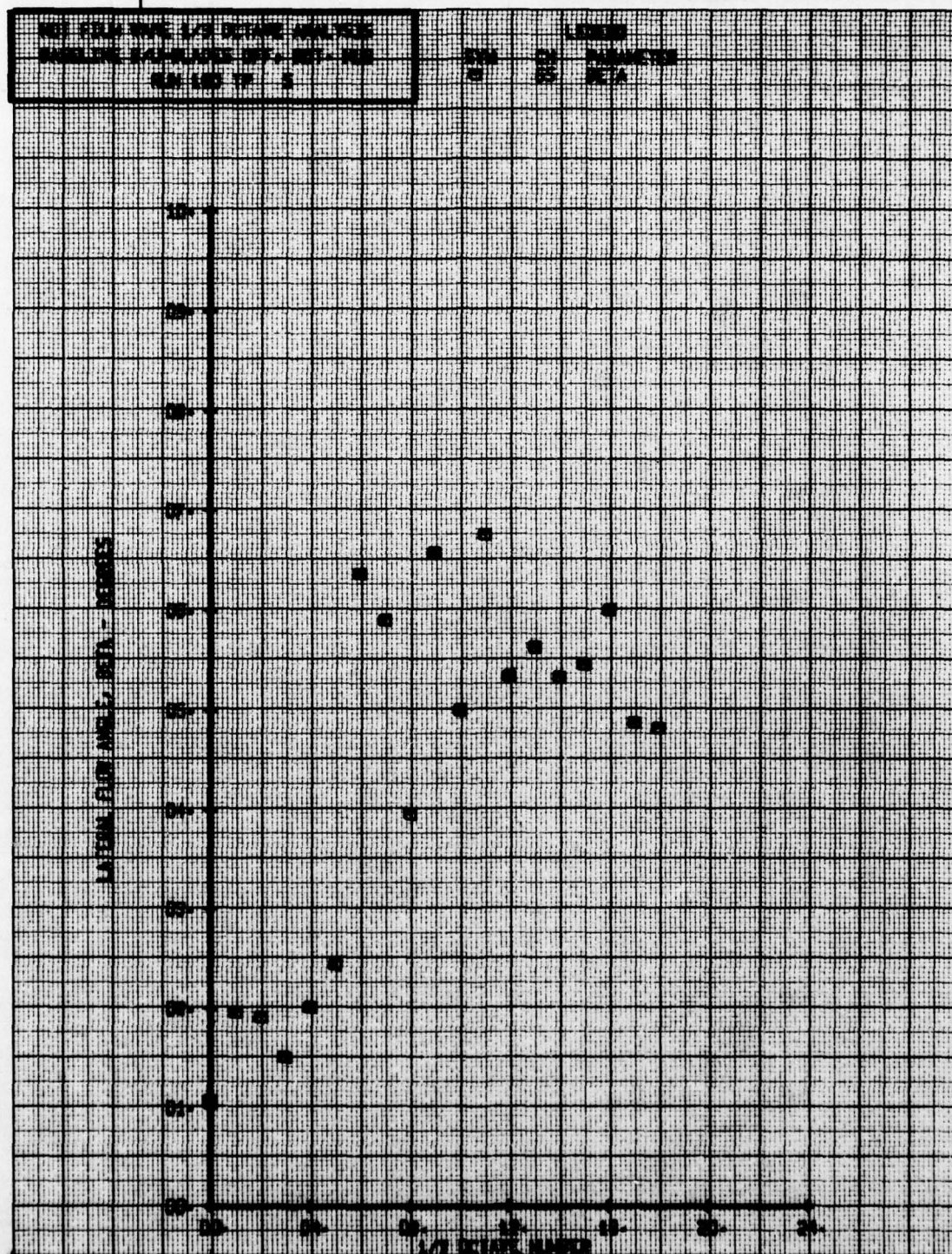
NOT FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE 8/11 BLADES OFF. DET. MIN  
 RUN 150 TP 10

SYN CH LEAD  
 G 55 ALPHA  
 PARAMETER





**THE**



100-443887-100





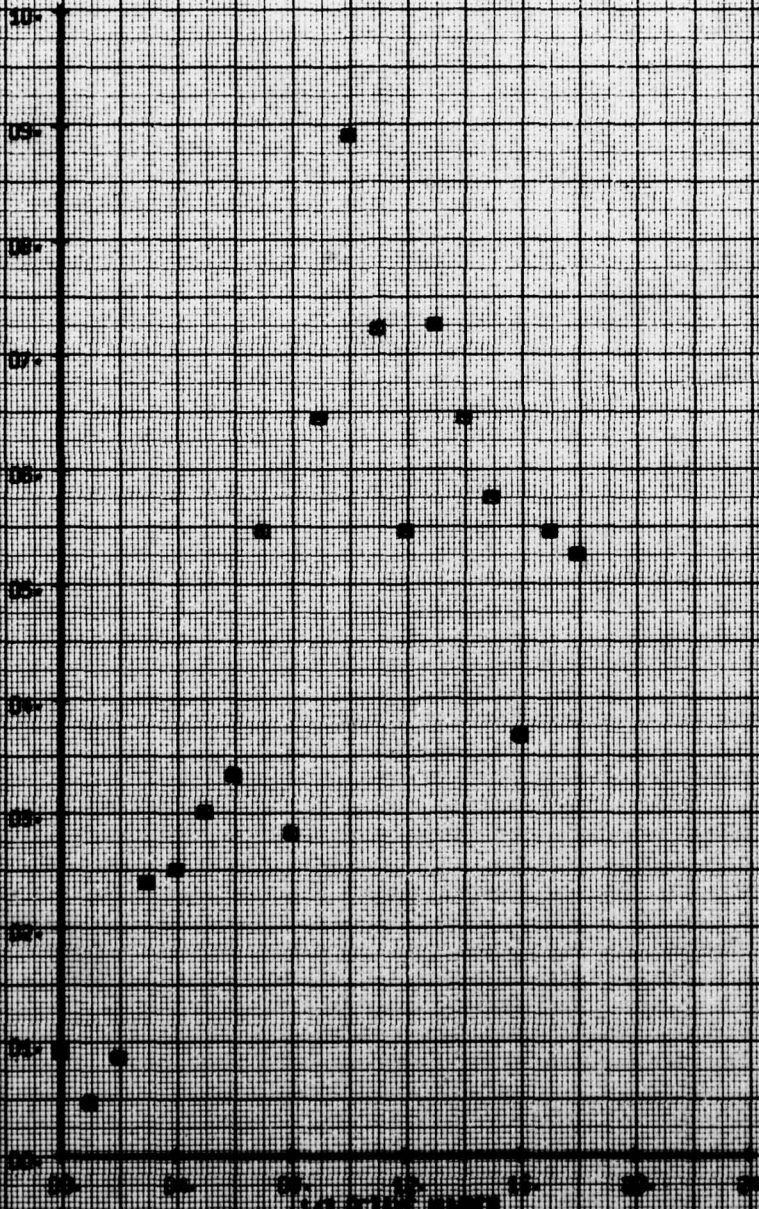
NOT FILM WIRE 1/3 OCTAVE ANALYSIS  
 BASELINE 8/4-BLADES OFF, RET. 140  
 RUN 100 TP 7

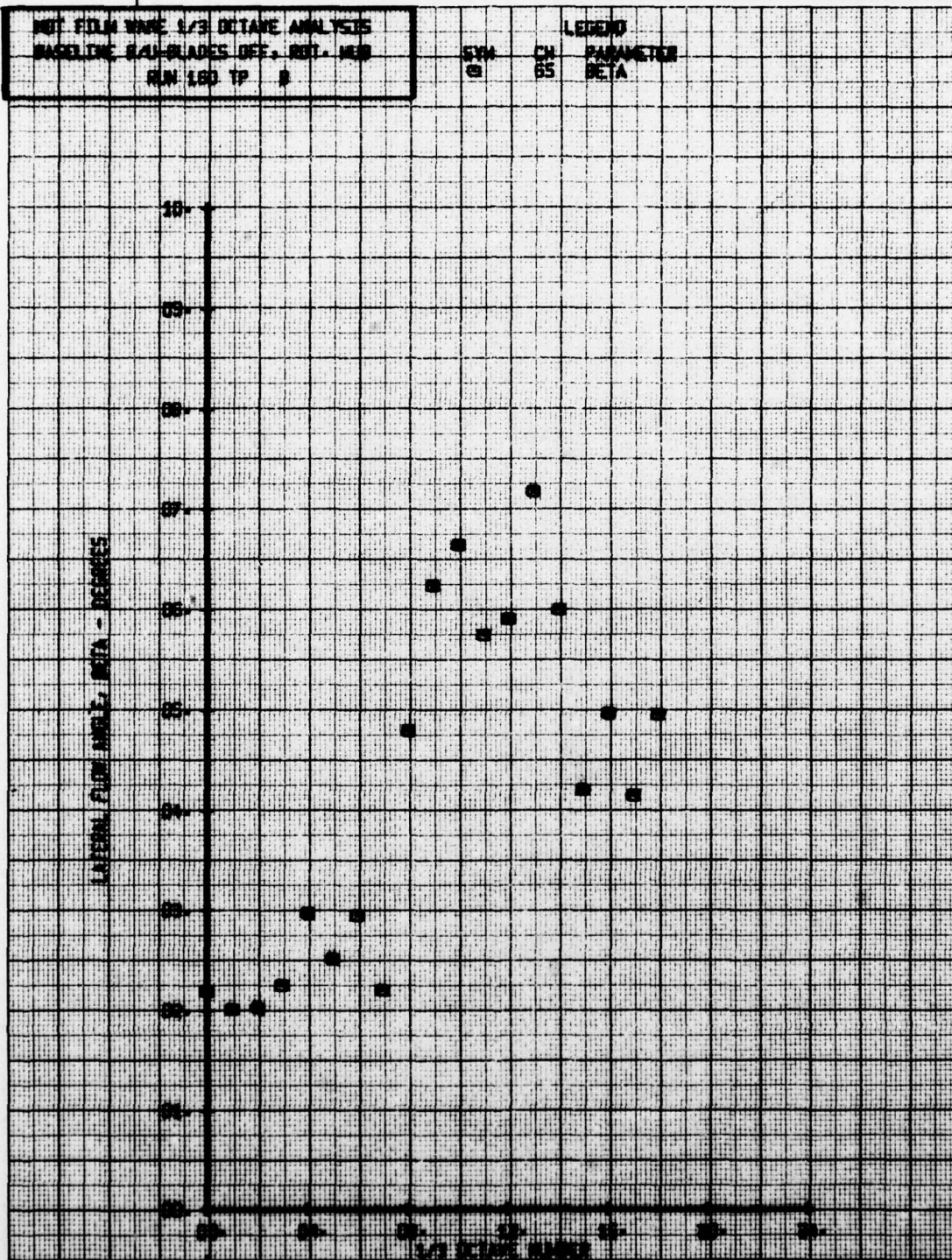
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LEGEND  
 PARAMETER  
 BETA

LATERAL FLUX ANGLE, BETA - DEGREES



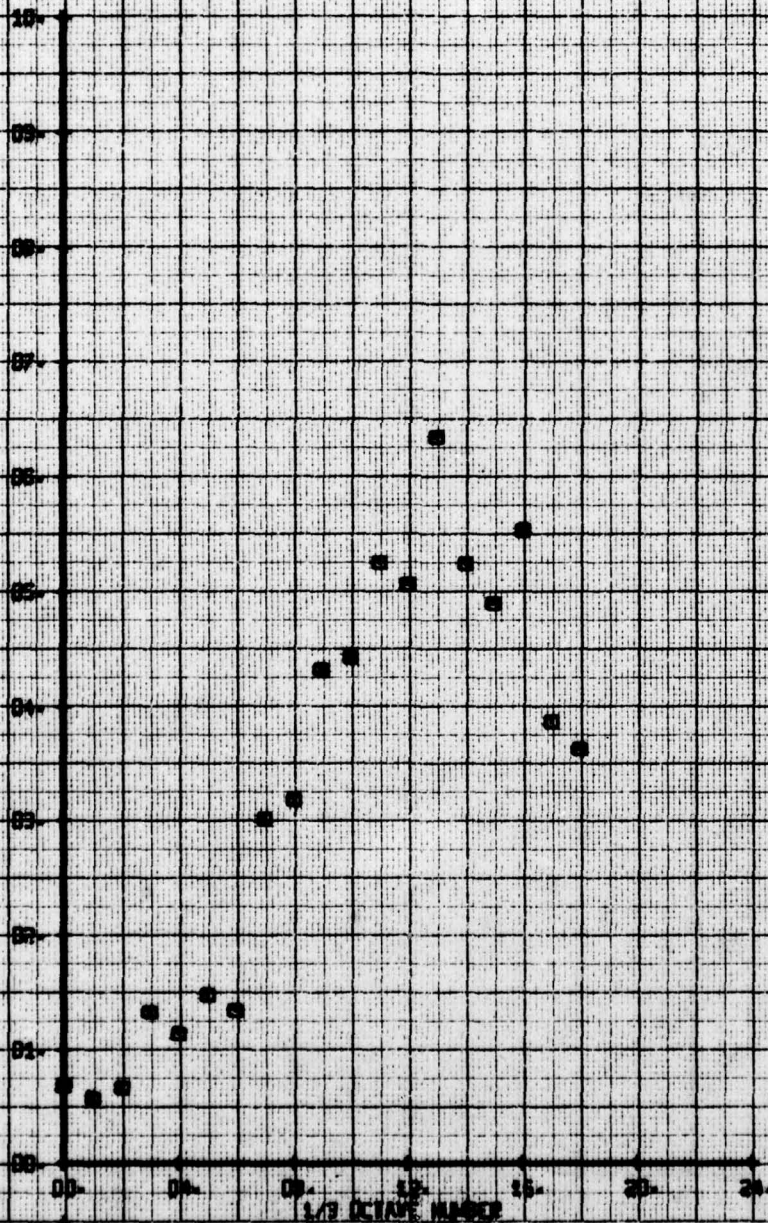




NET FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE 841-8465 DEF. INT. REF  
 RUN 180 TP 5

SYN CH  
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 PARAMETER  
 DELTA

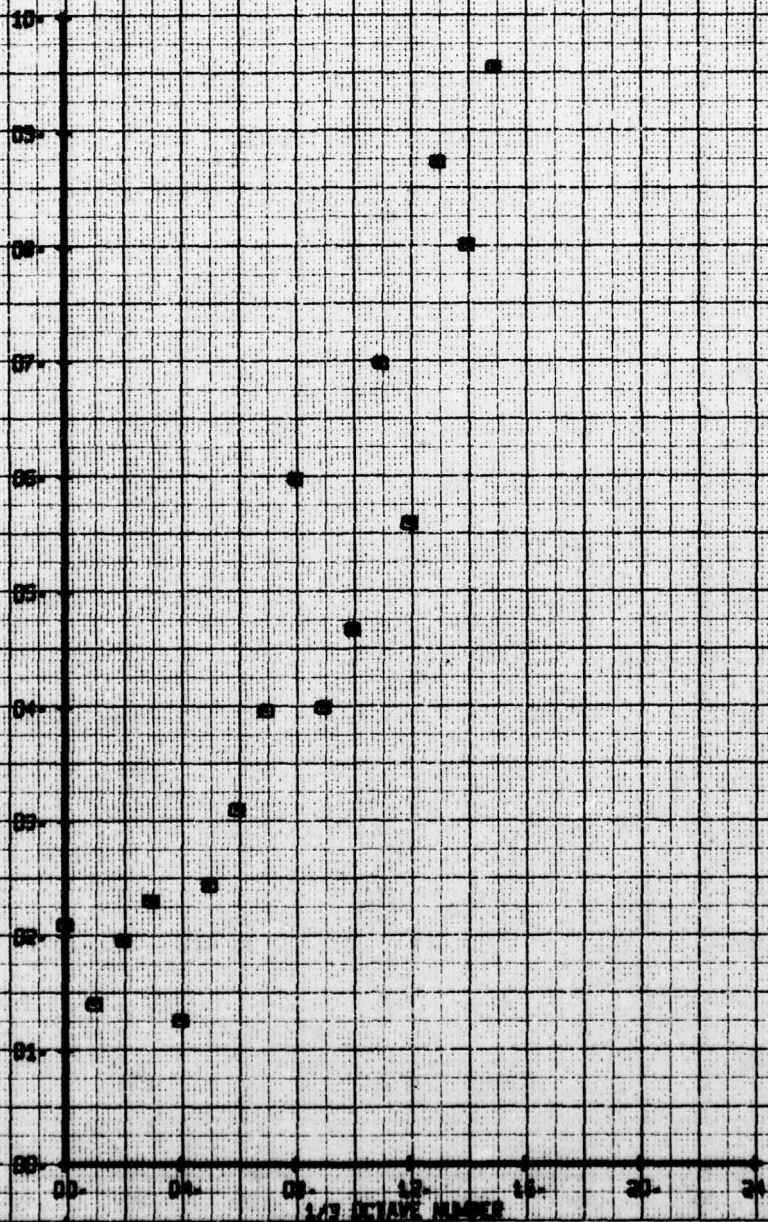
LATERAL FLOW ANGLE, DEGREES



NET FILM WIRE 1/3 OCTAVE ANALYSIS  
 BASELINE 8-11 BLADES OFF. ROT. NEG  
 RUN 180 TP 18

LEGEND  
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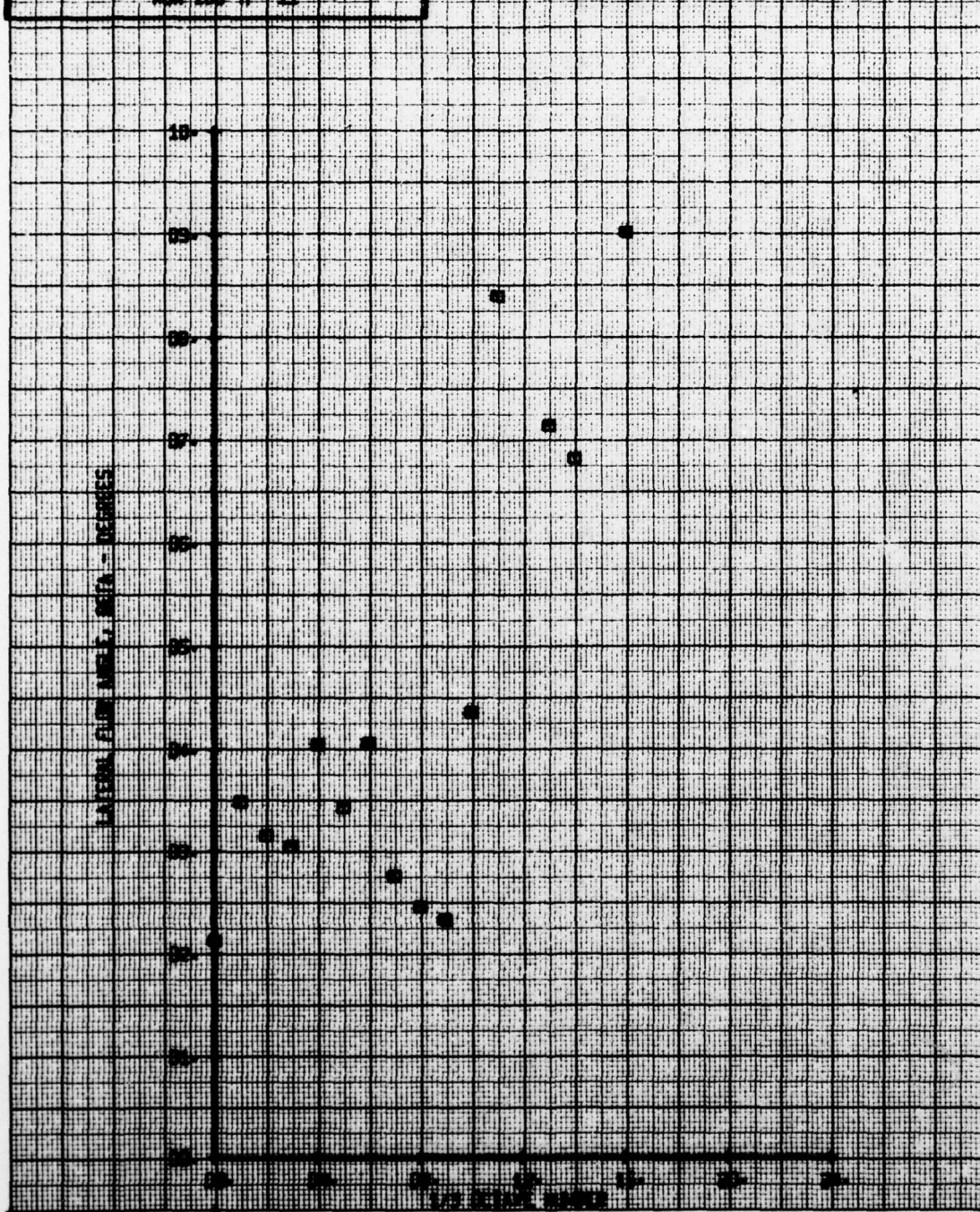
LATERAL FLOW ANGLE, BETA - DEGREES

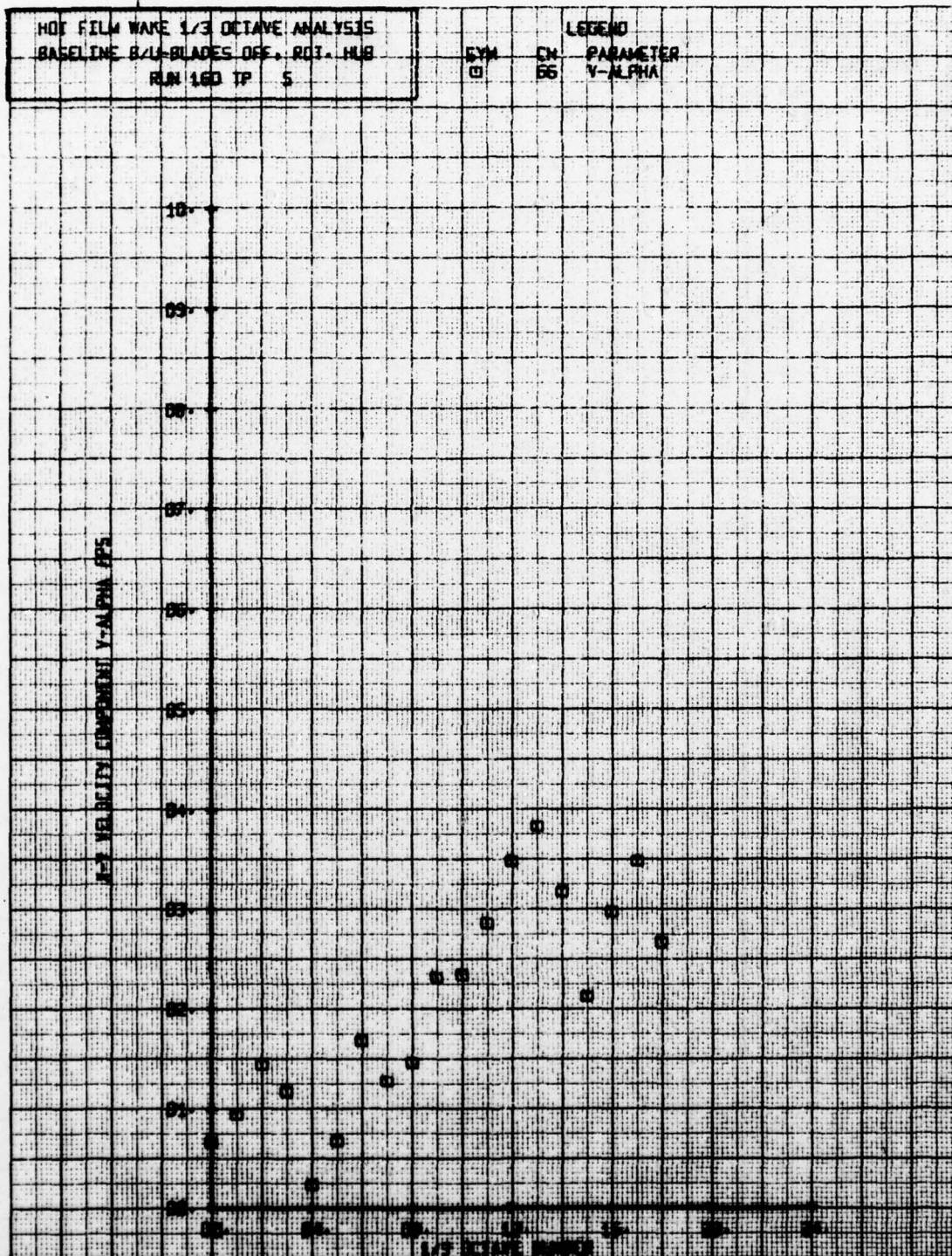




NOT FILM WIRE 1/3 OCTAVE ANALYSIS  
 BASELINE 8.41-8.45 DEC. 1971. MIB  
 RUN 169 TP 11

SYM CH PARAMETER  
 @ 55 BETA

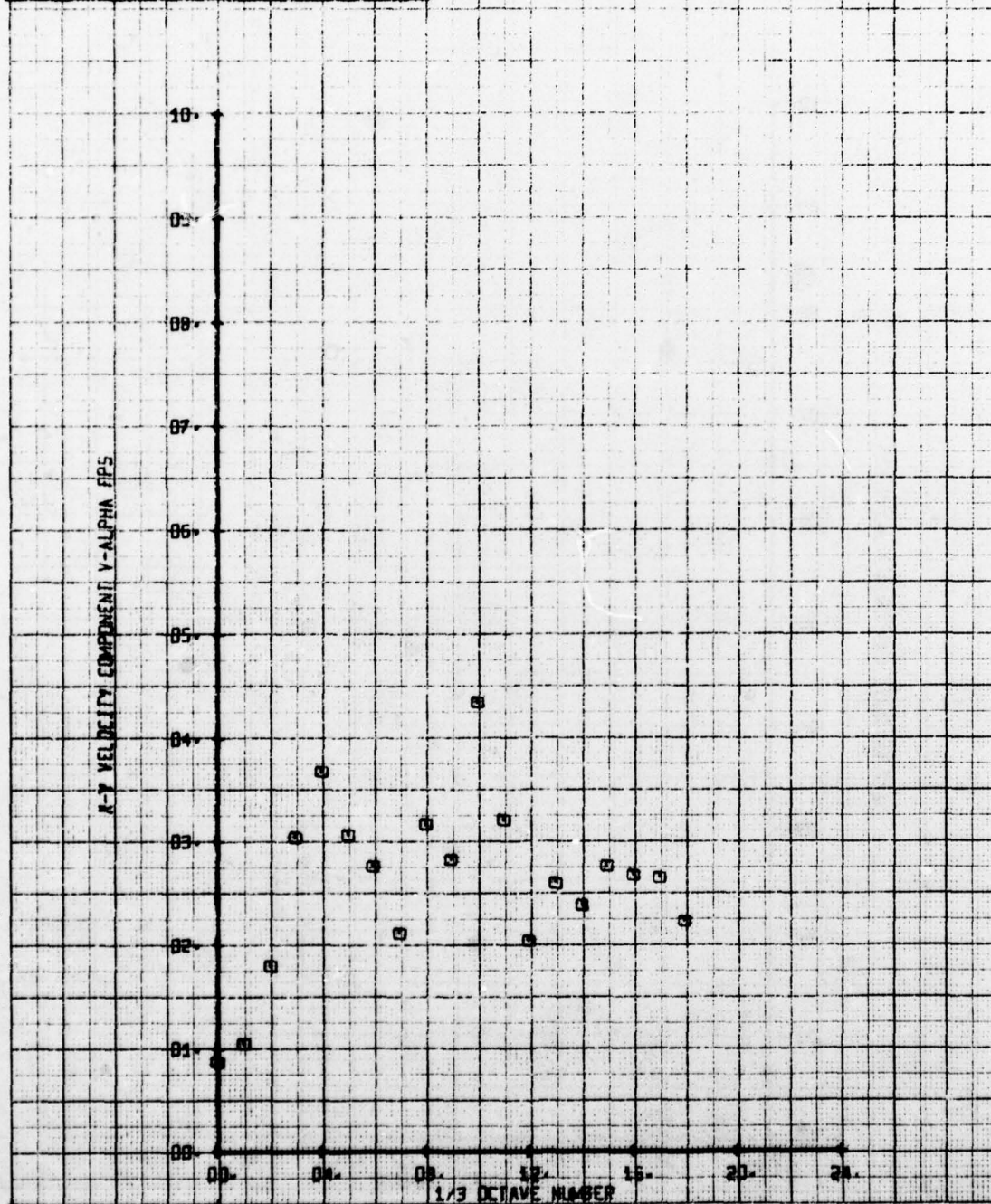


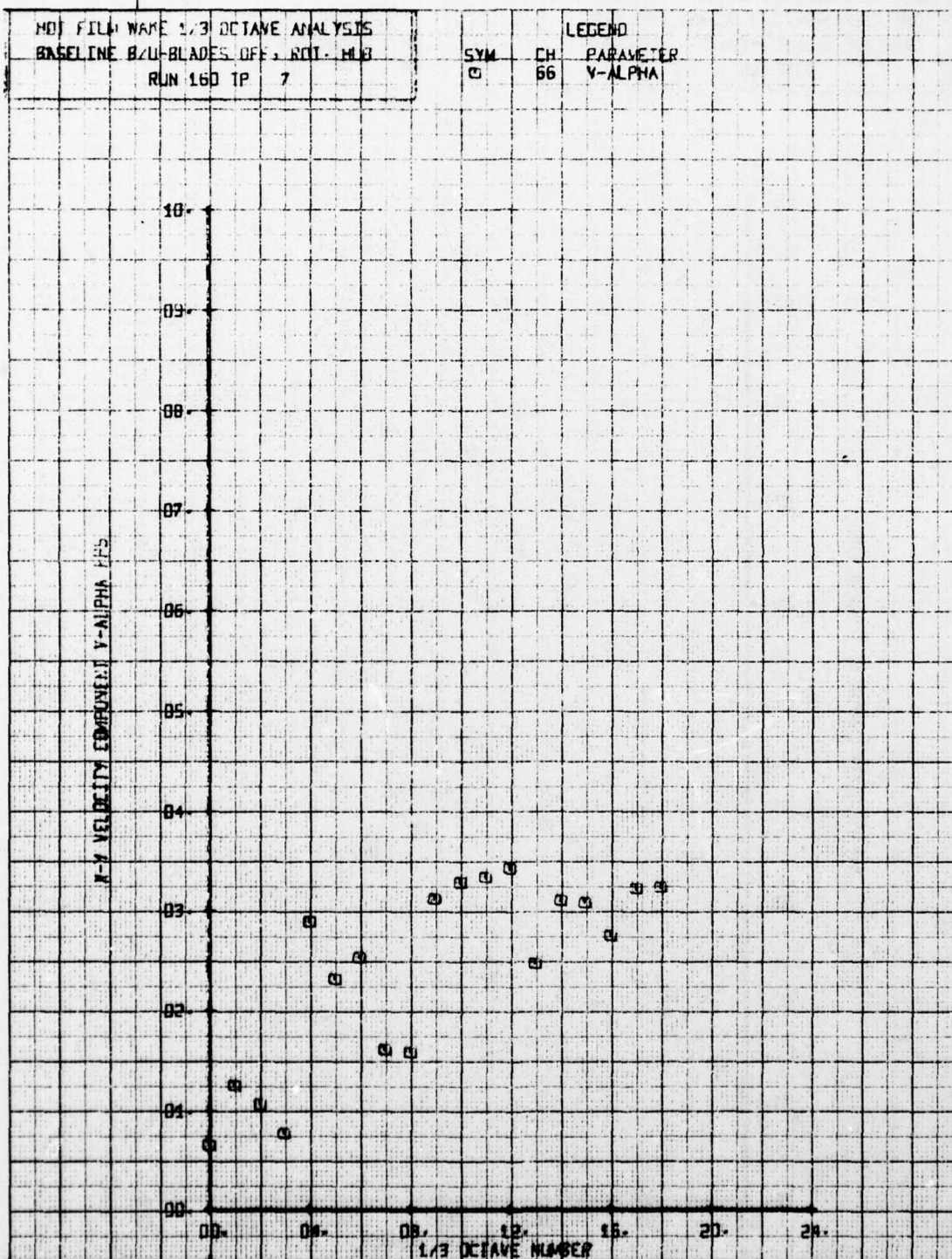




HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE B/U-BLADES OFF, ROT. HUB  
 RUN 160 TP 6

SYN CH  
 66 66  
 PARAMETER  
 V-ALPHA







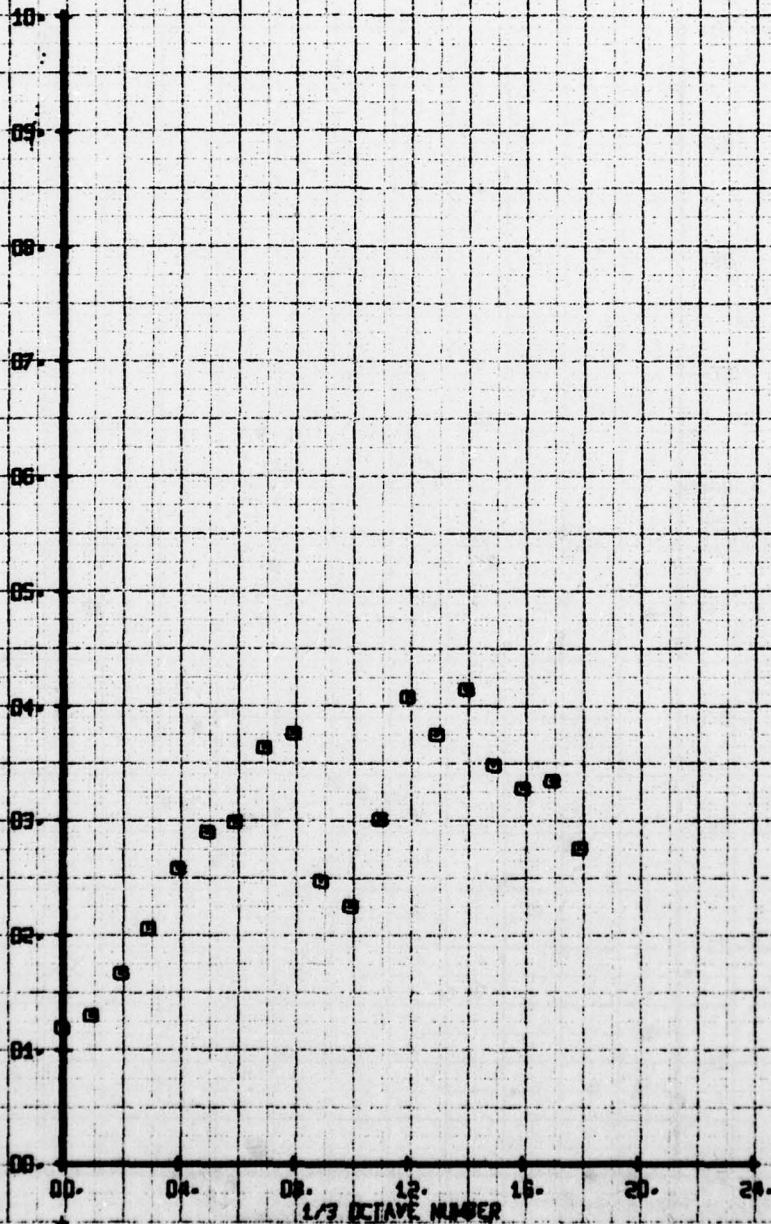
HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE 840-BLADES OFF, ROT. HUB  
 RUN 160 TP 8

SYM  
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LEGEND  
 PARAMETER  
 V-ALPHA

A-Y VELOCITY COMPONENT V-ALPHA FPS

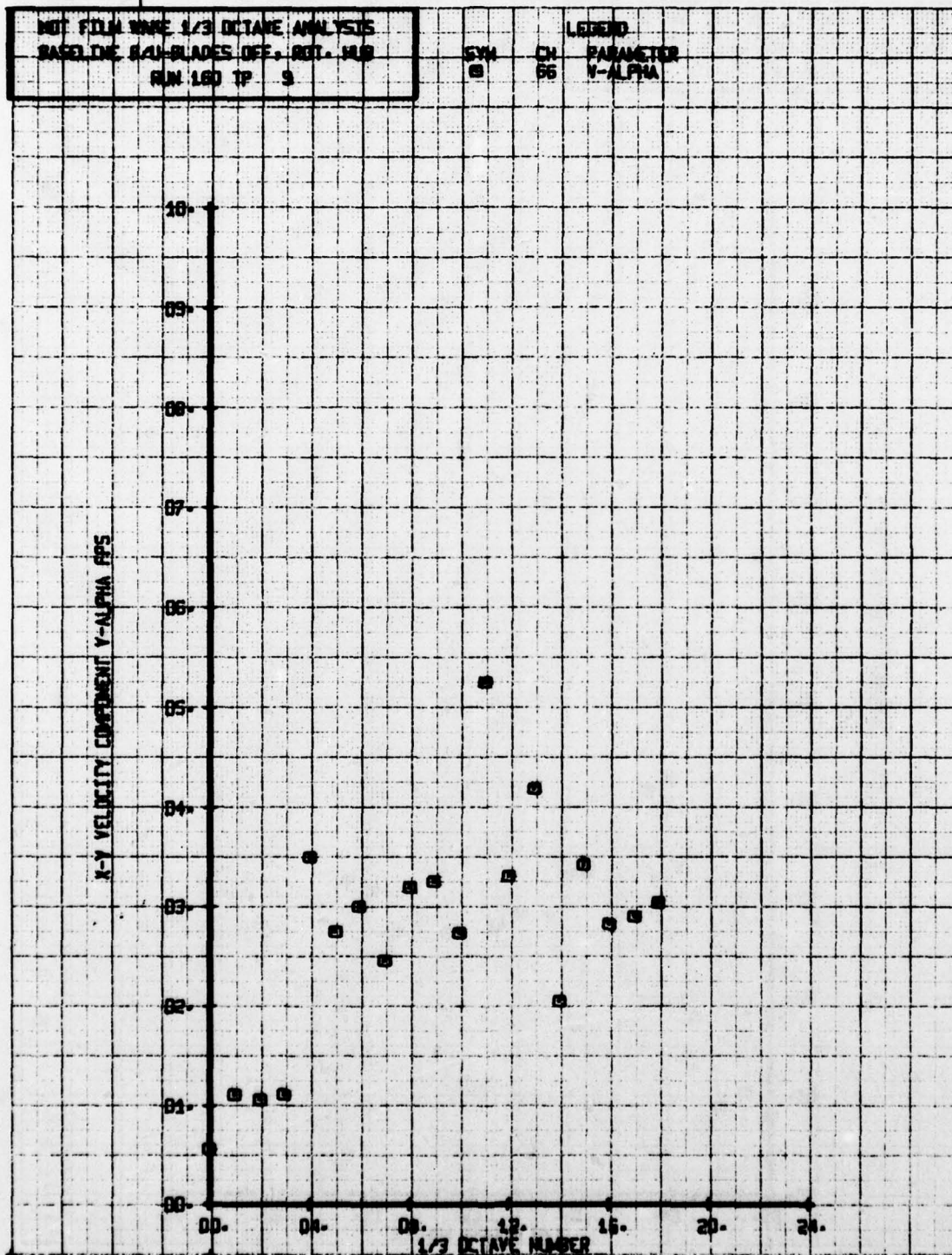


NOT FILM WIRE 1/3 OCTAVE ANALYSIS  
BASED ON 840-BLADES OFF. ROT. HUB  
RUN 180 TP 9

SYM  
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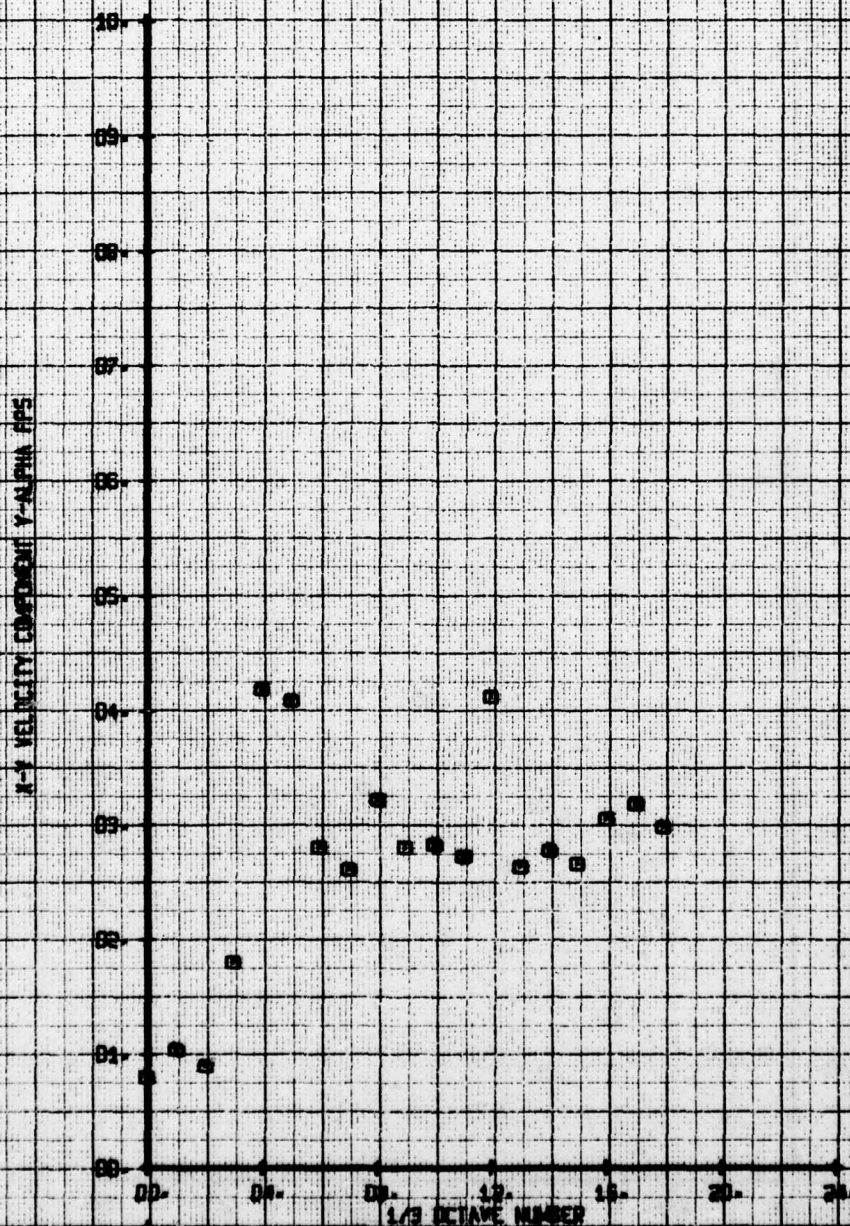
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LEGEND  
PARAMETER  
V-ALPHA





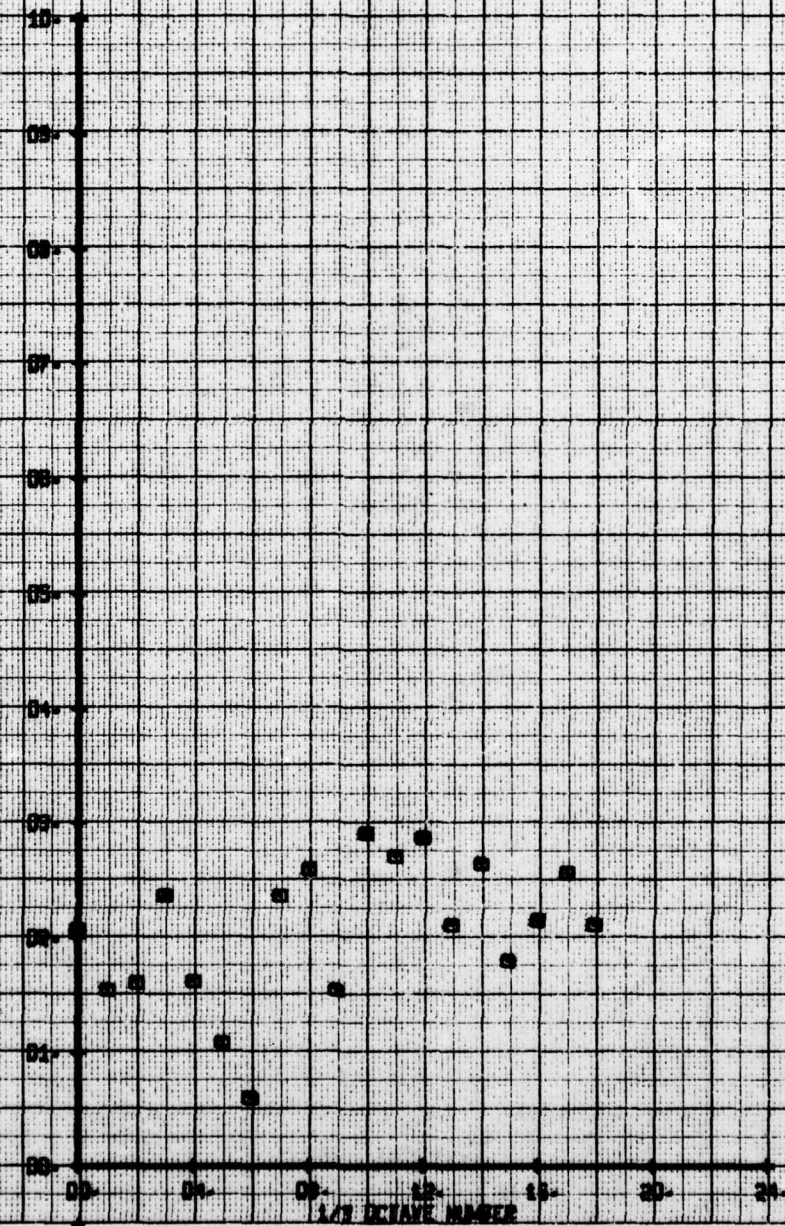
LEGEND		
SW	CH	PARAMETER
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NOT FILM TYPE 1/3 OCTAVE ANALYSIS  
 BASELINE 240-245 DB. REF. 100  
 RUN 100 TP 11

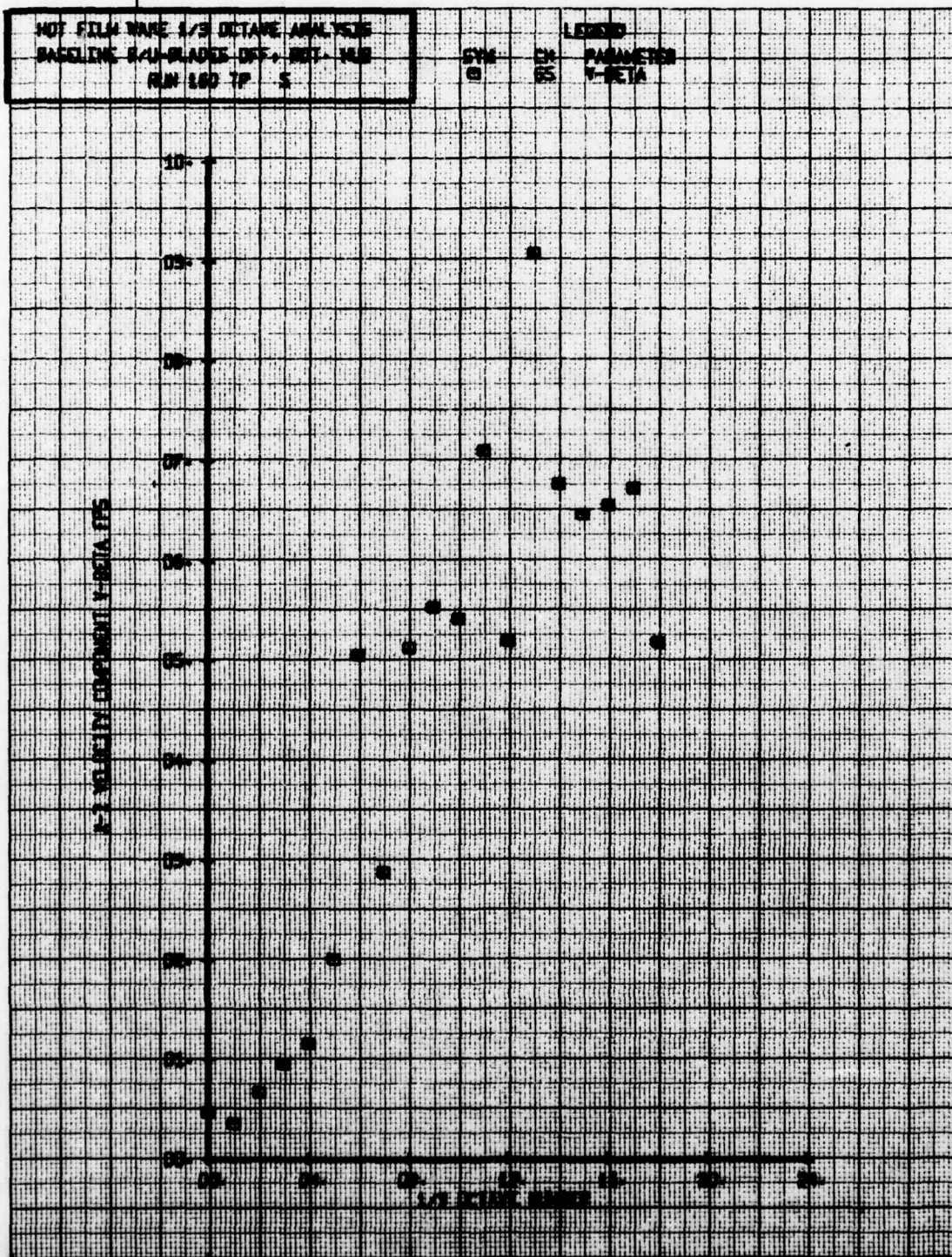
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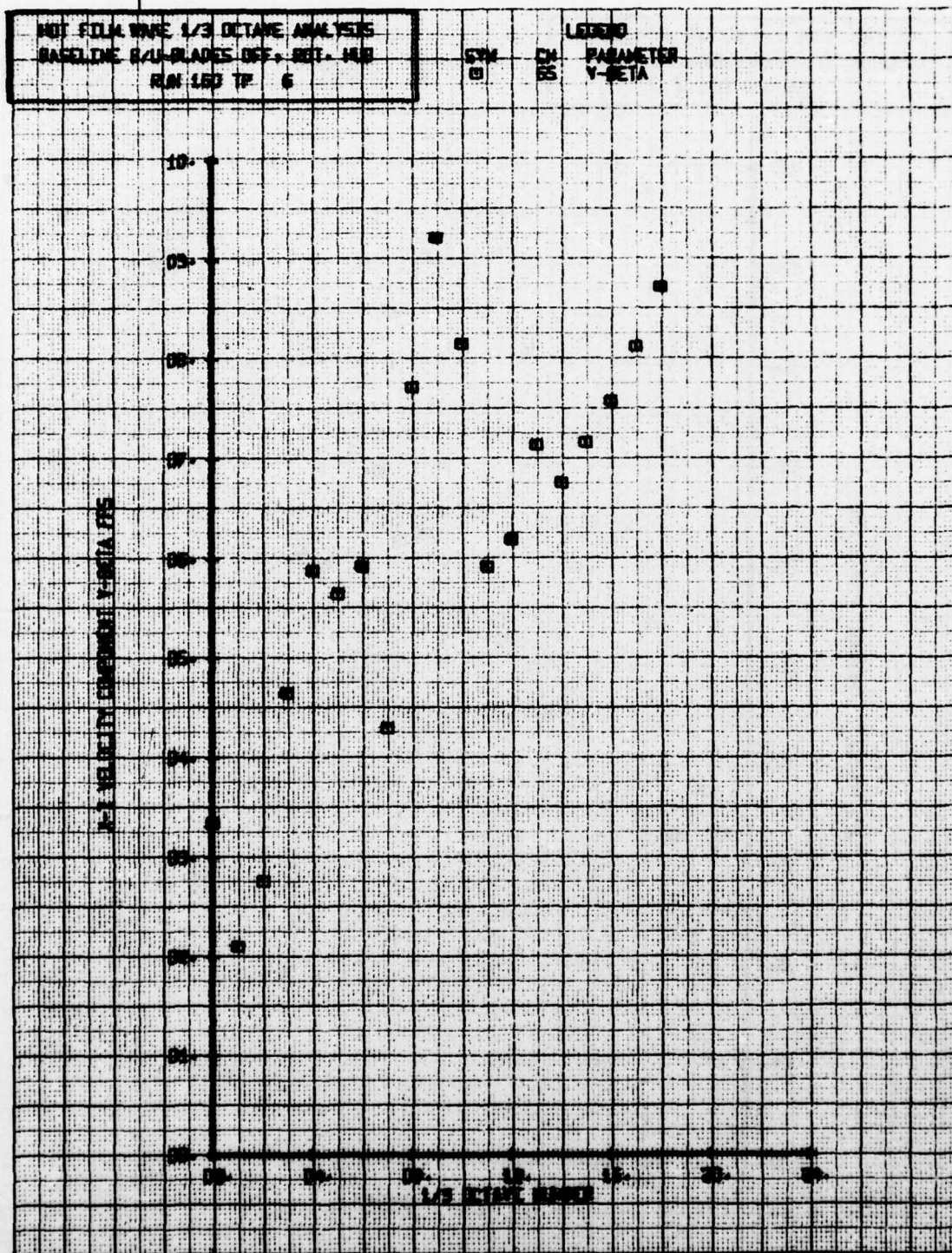
1/3 OCTAVE NUMBER



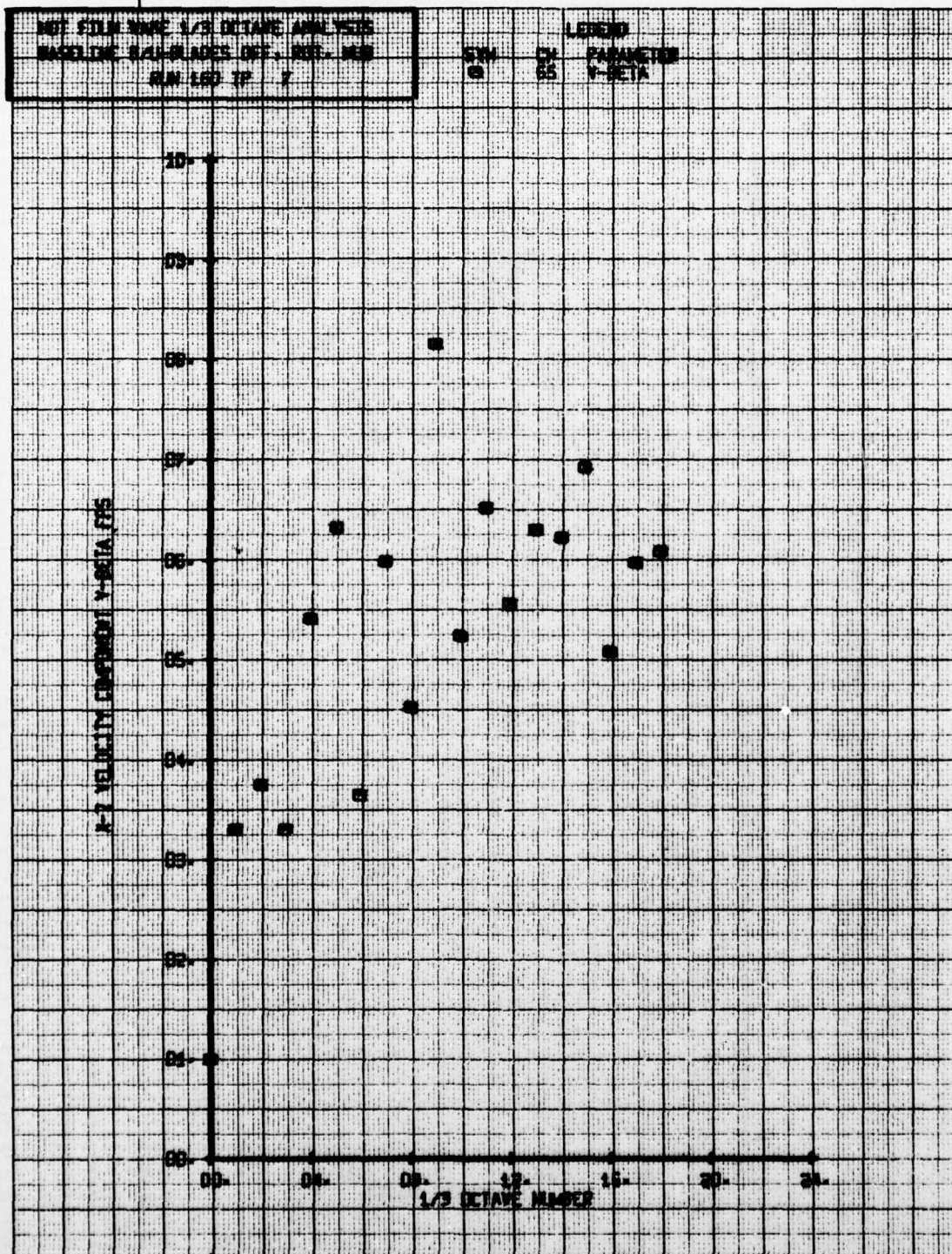


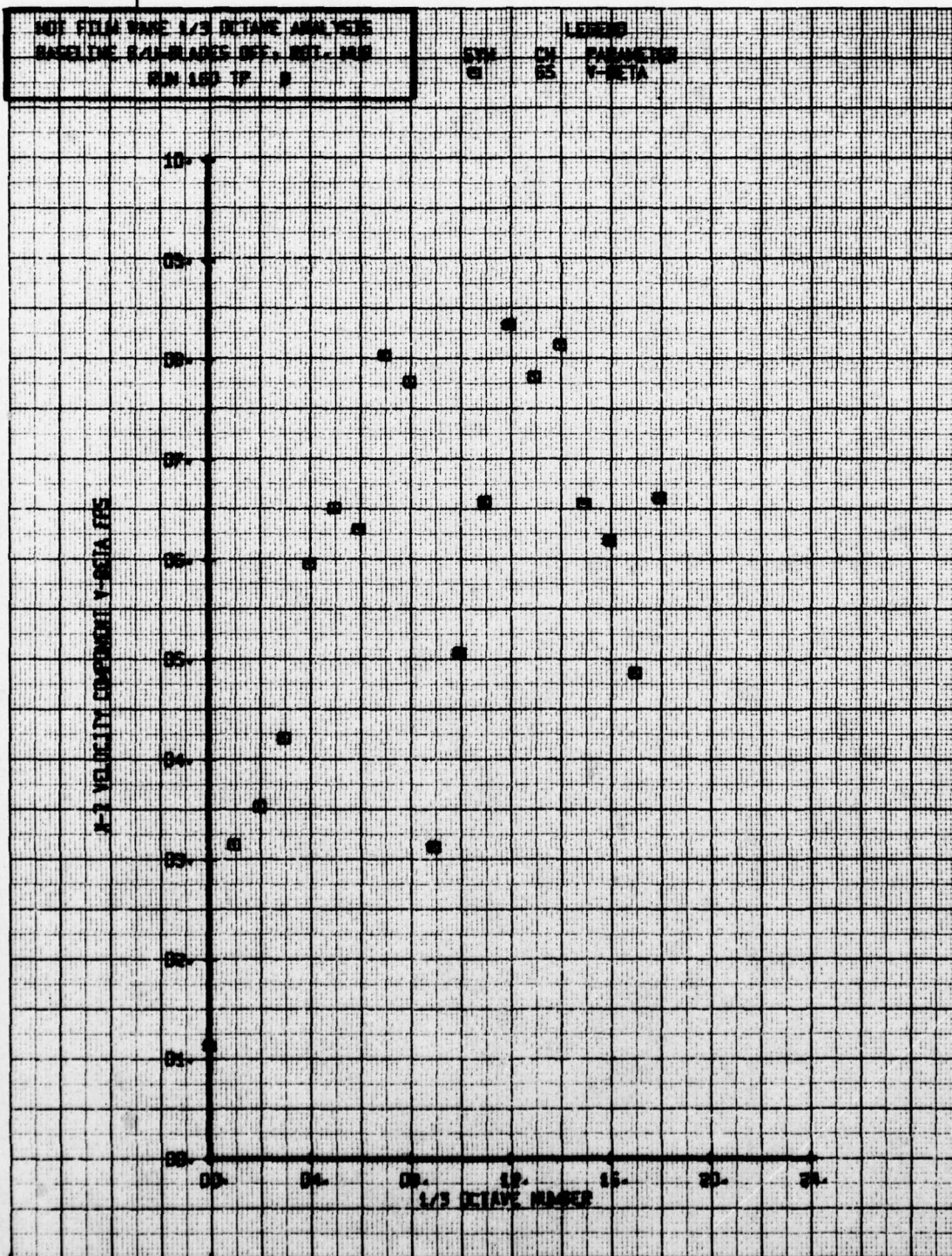
TYPE	CLASS	LEADS
Q	BS	PARAMETER T-BETA





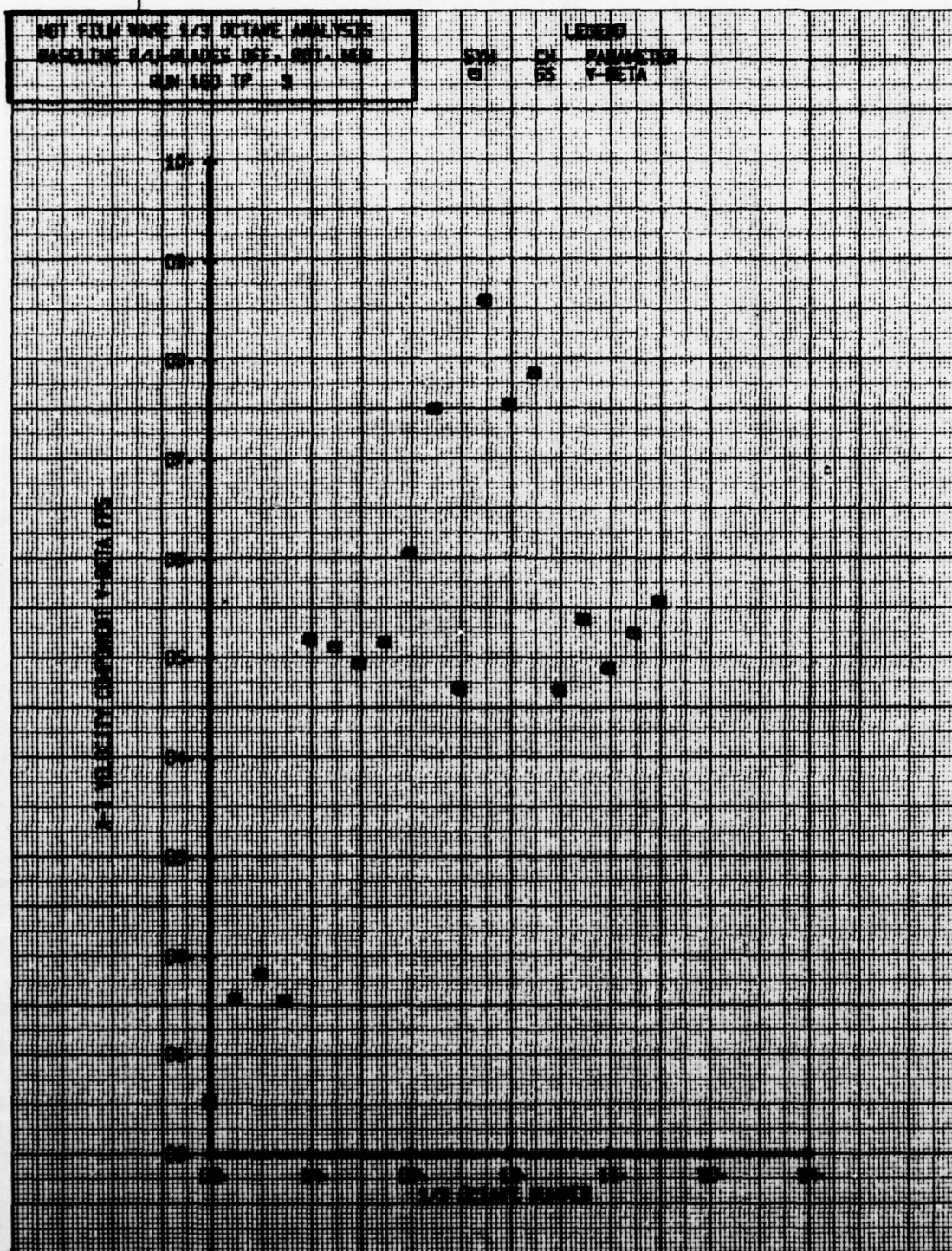


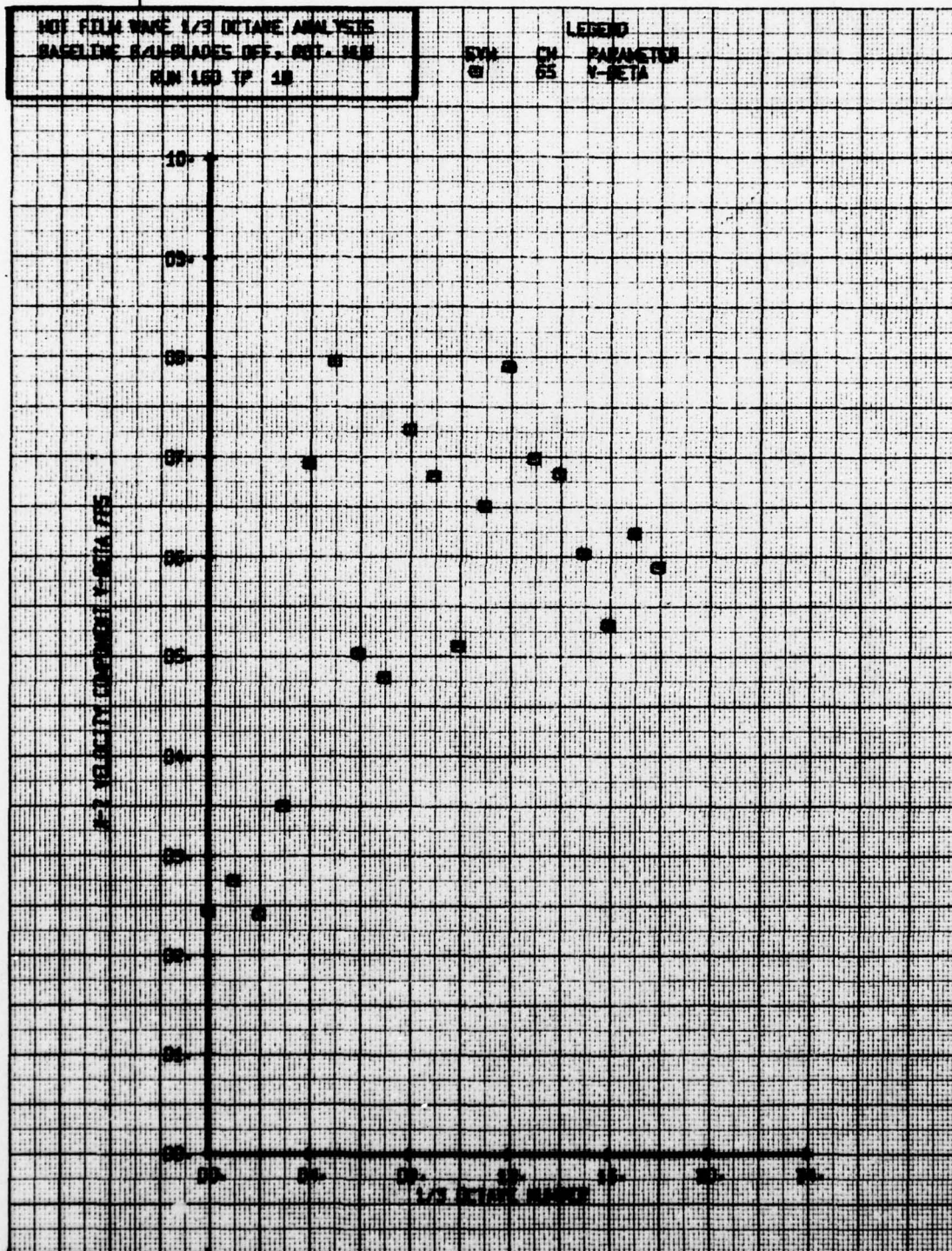






LEADS		PARAMETER
SYM	CU	V-BETA







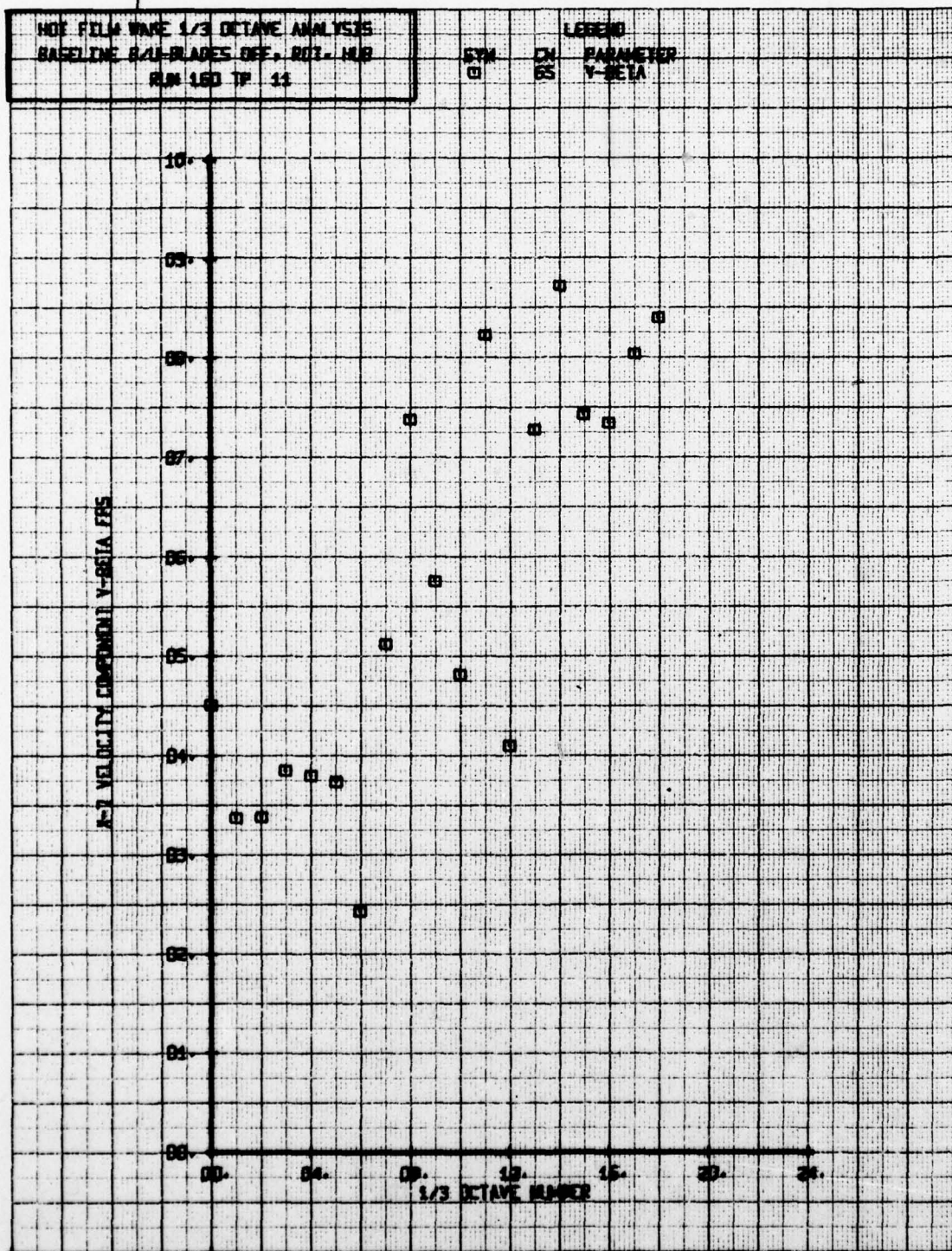
NOE FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE 8/11 BLADES OFF, ROT. HUB  
 RUN 160 TP 11

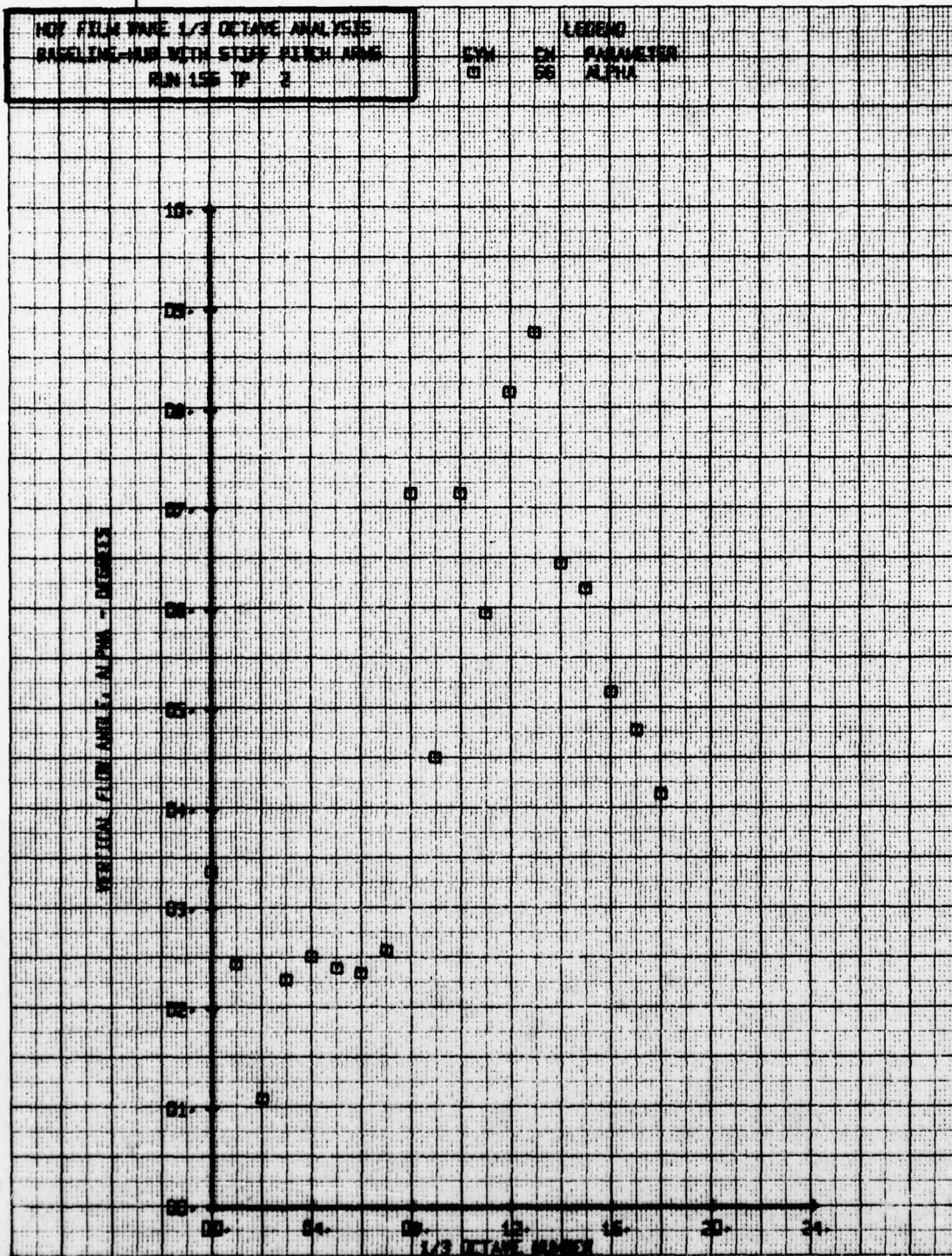
SYM  
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CN  
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LEGEND  
 PARAMETER  
 Y-BETA

A-7 VELOCITY COMPONENT Y-BETA FFS

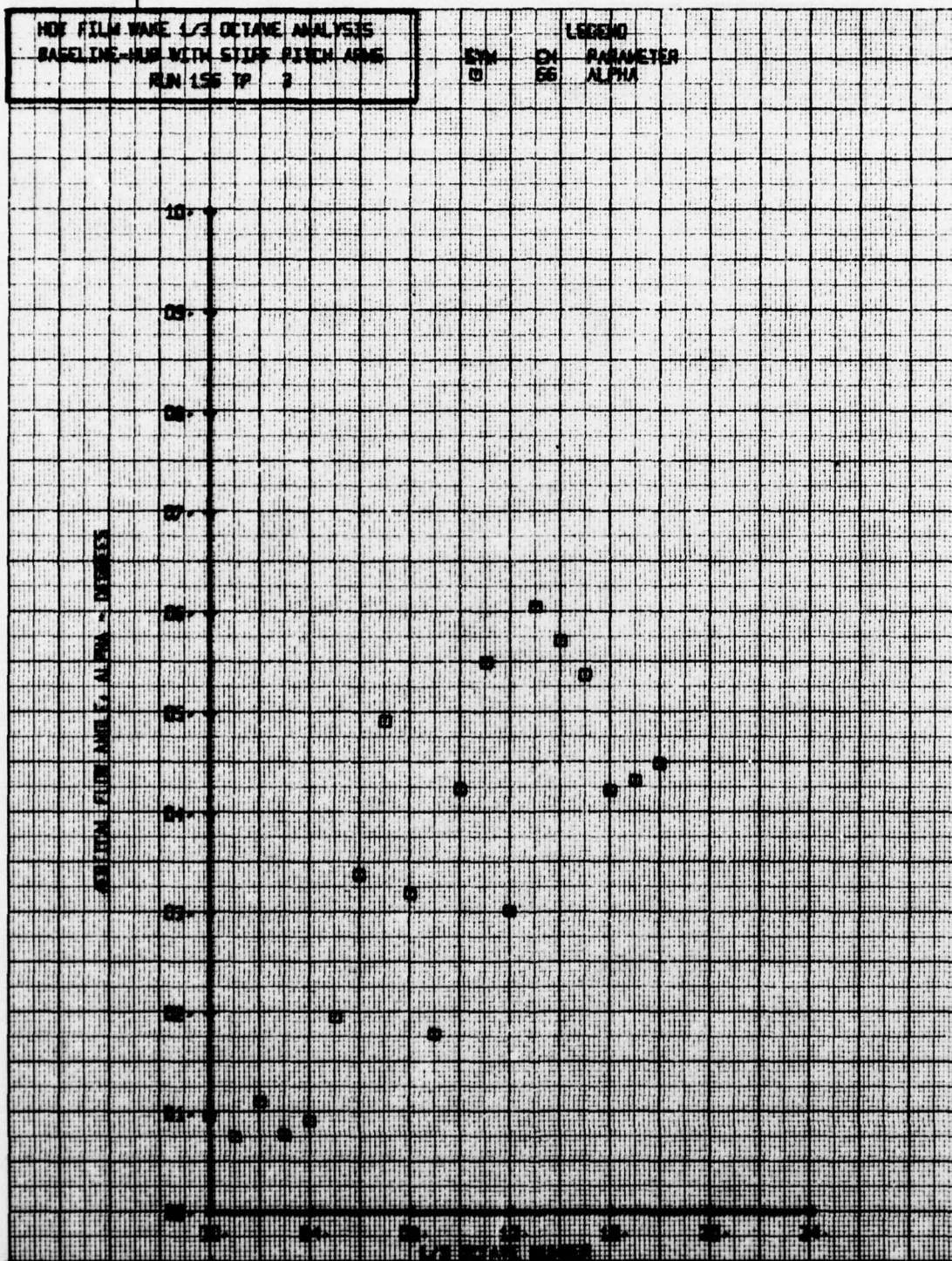






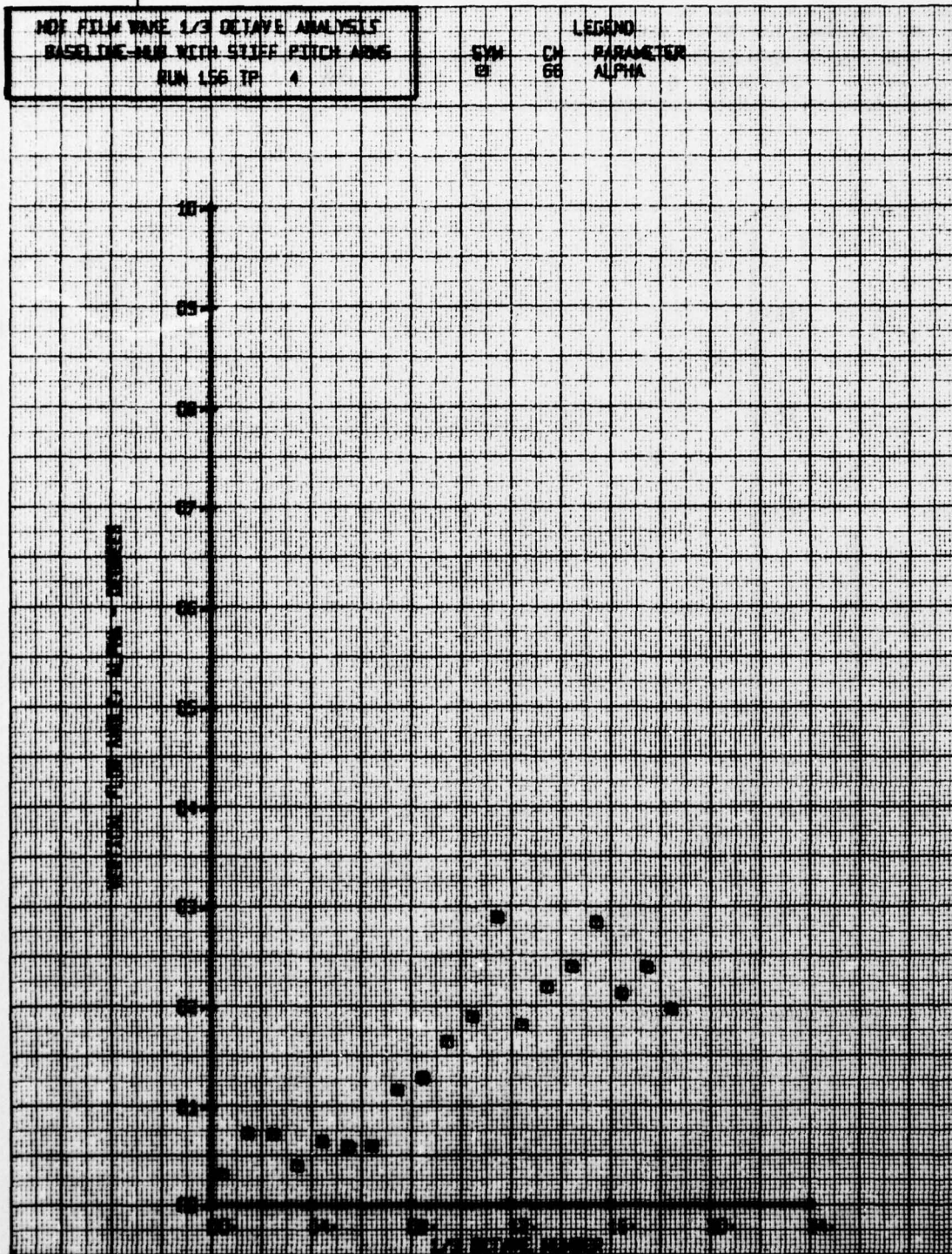
HOB FILM WAKE  $\sqrt{3}$  OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF FINCH ARMS  
 RUN 156 TP 3

SYM CH PARAMETER  
 01 66 ALPHA



NOE FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-MIN WITH STIFF PITCH ARMS  
 RUN 156 TP 4

SYN CH  
 68 68  
 PARAMETER  
 ALPHA





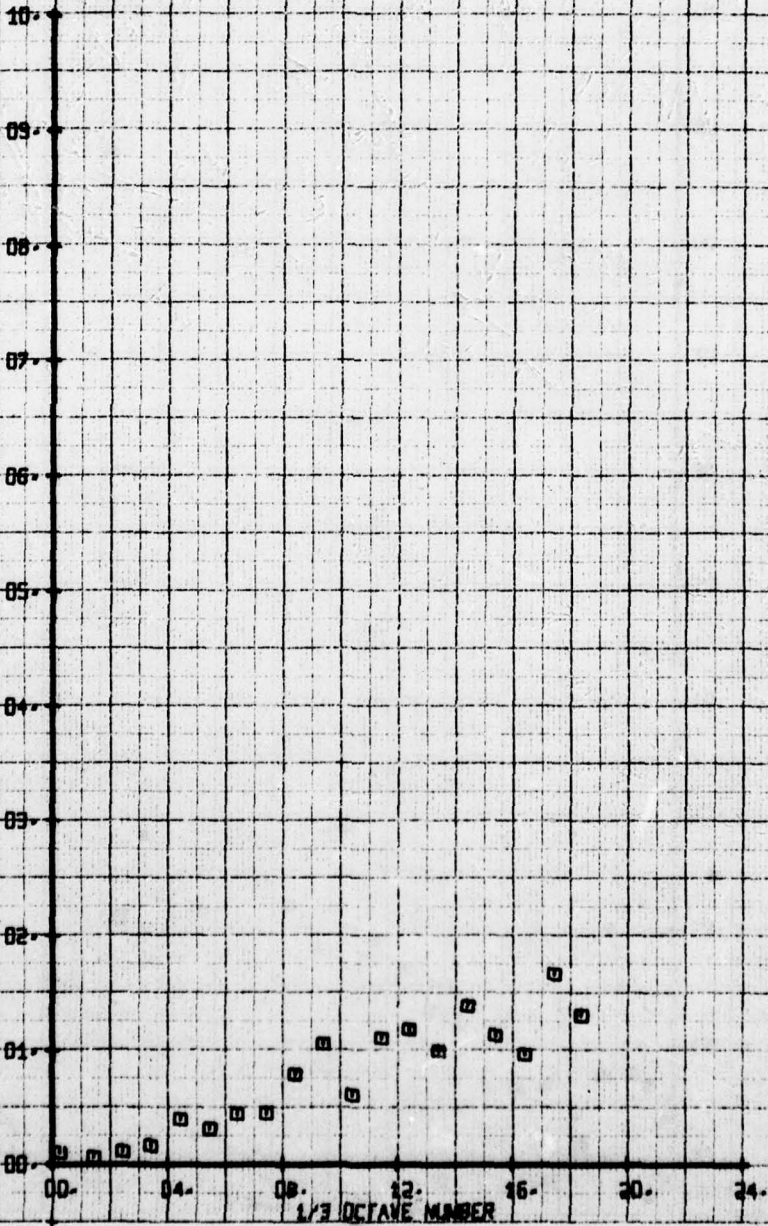
NOI FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE-MUG WITH STIFF PITCH ARMS  
 RUN 156 TP 5

SYM  
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CH  
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LEGEND  
 PARAMETER  
 ALPHA

VERTICAL FLIGHT ANGLE, ALPHA - DEGREES



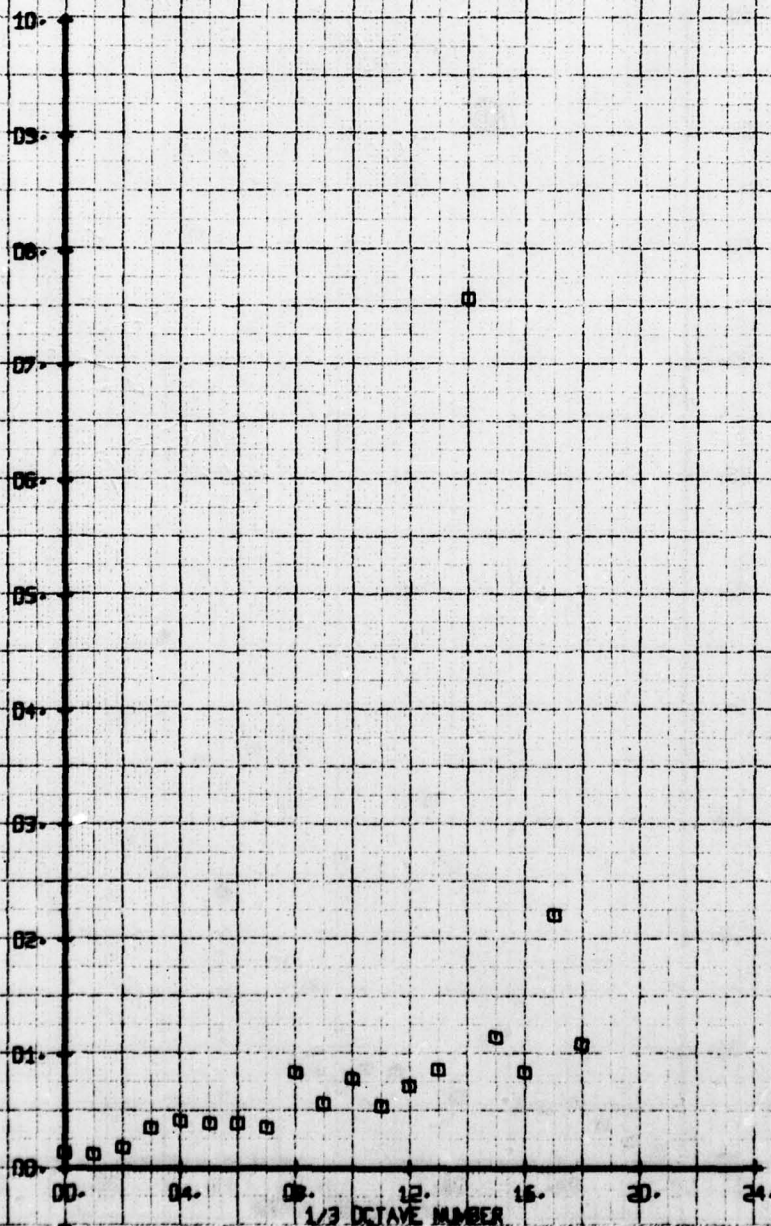
HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 155 TP 6

SYM  
 □

EN  
 66

LEGEND  
 PARAMETER  
 ALPHA

VERTICAL FLOW ANGLE, ALPHA - DEGREES

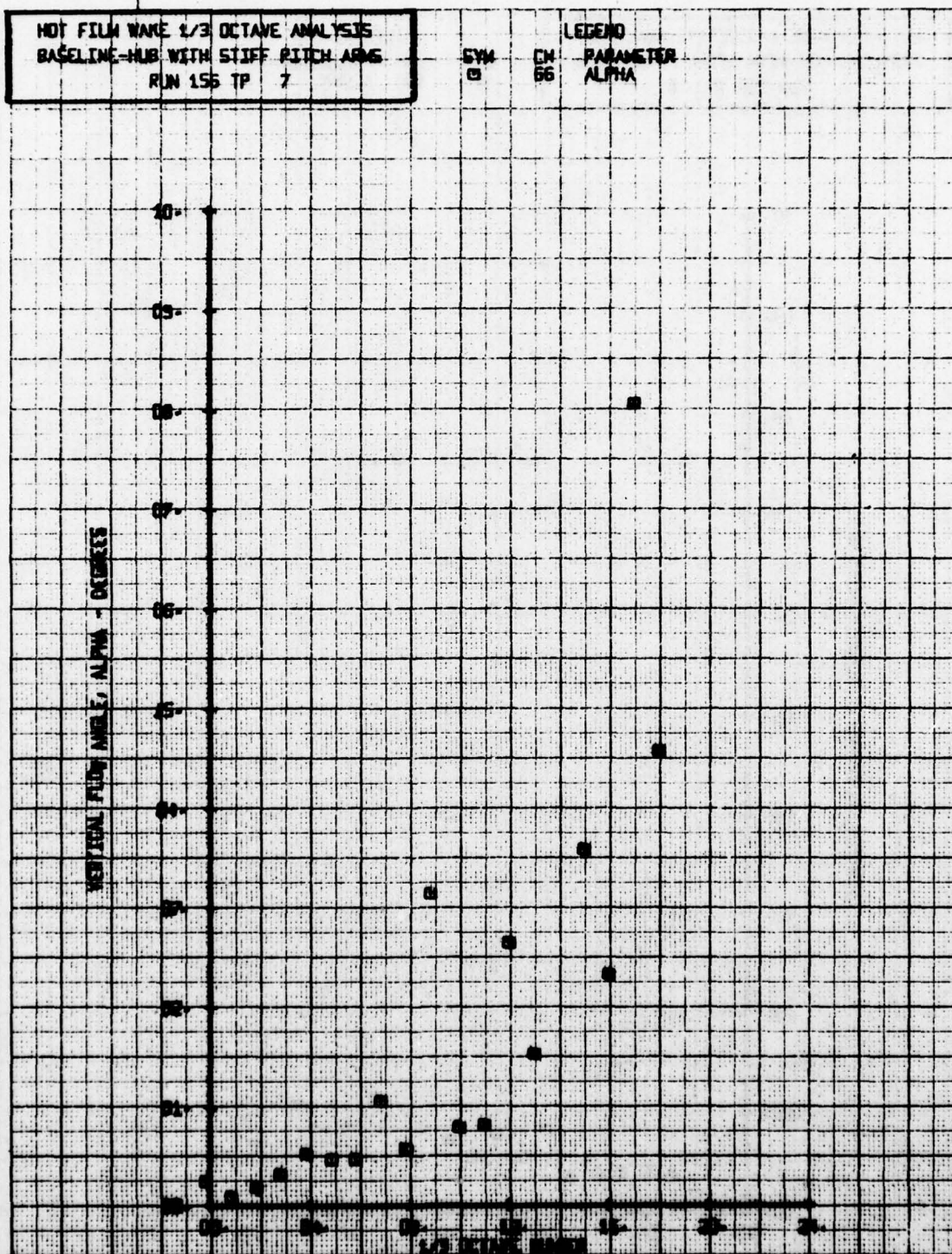


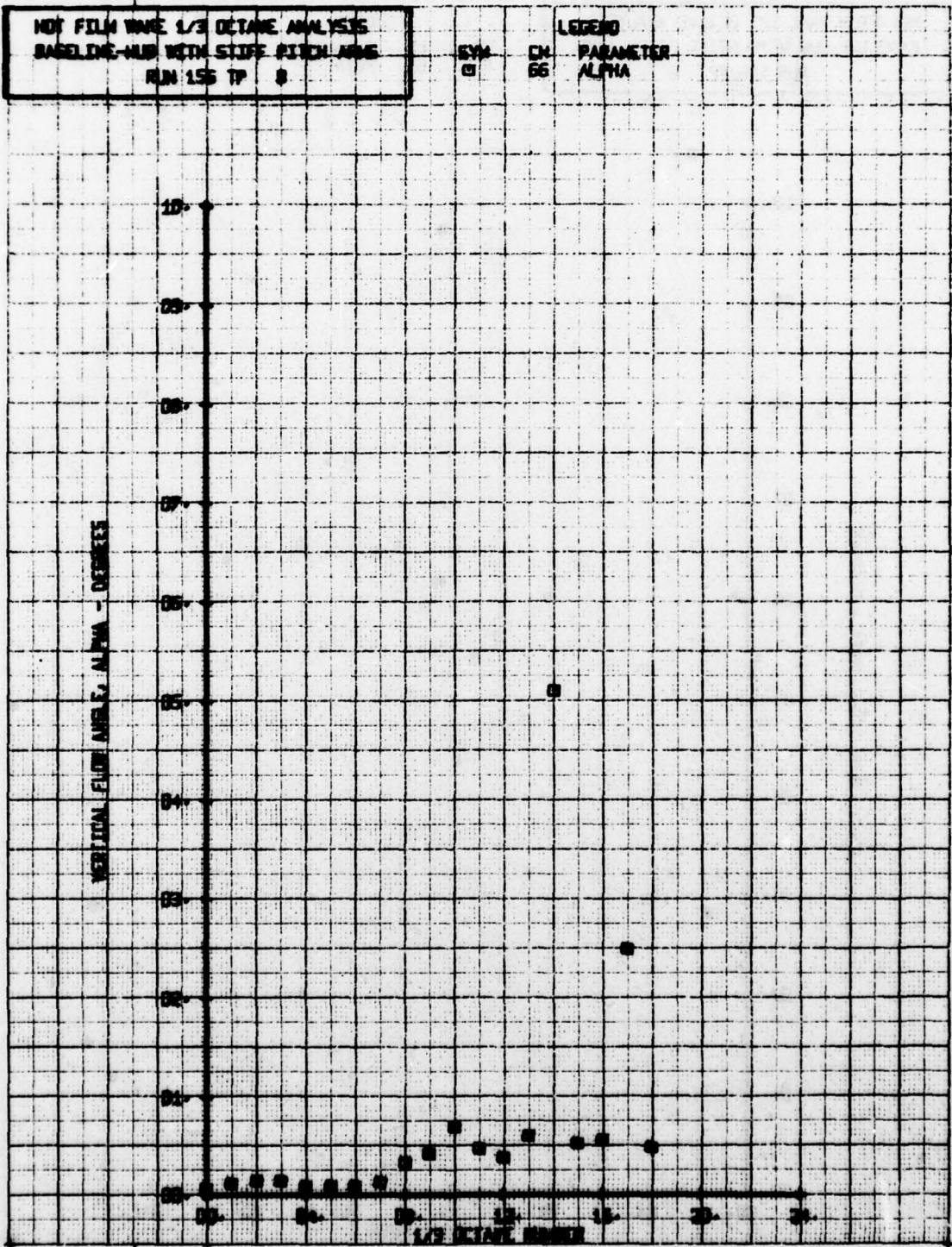


HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 155 TP 7

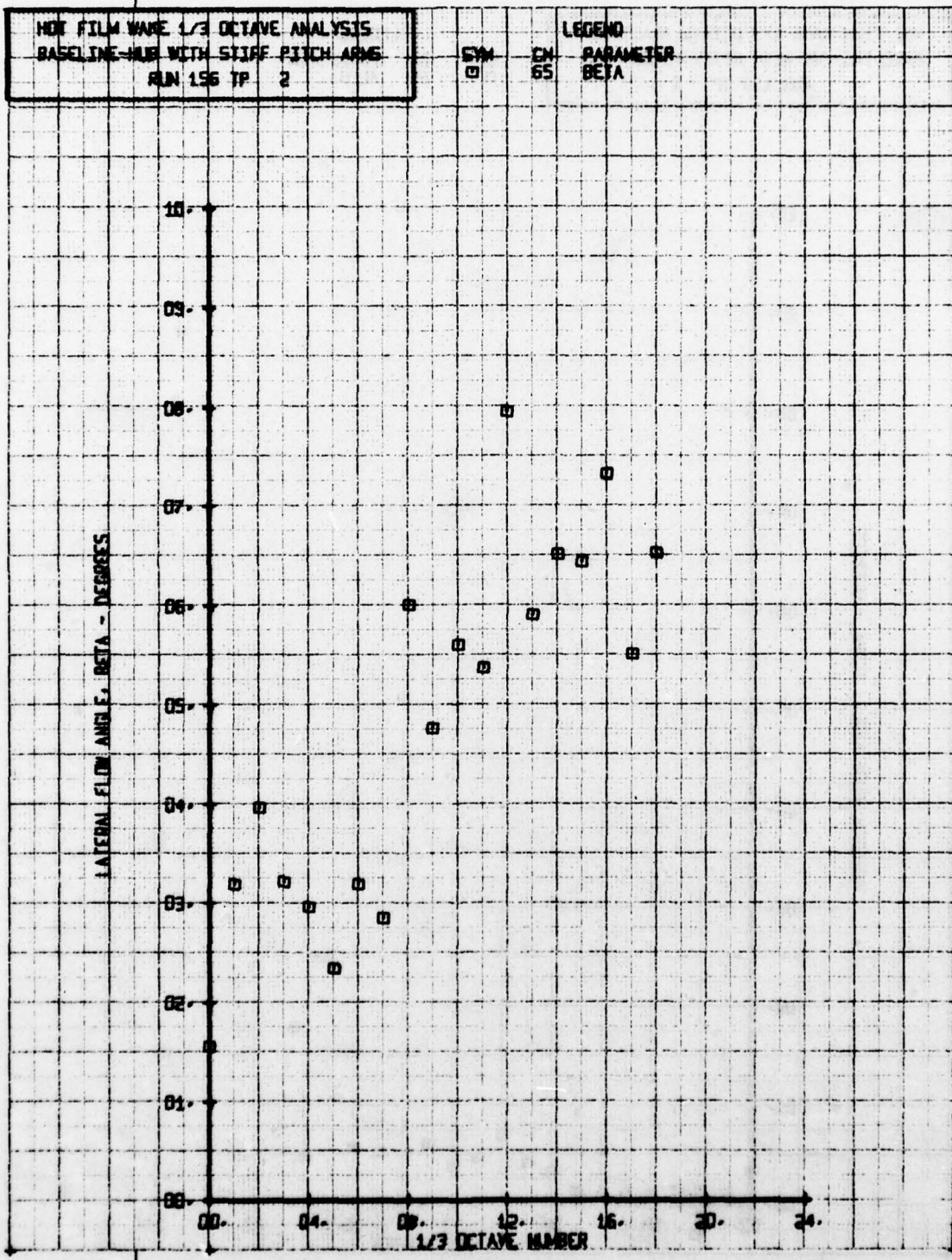
SYM CN  
 □ 66  
 LEGEND  
 PARAMETER  
 ALPHA

VERTICAL FLOW ANGLE, ALPHA - DEGREES









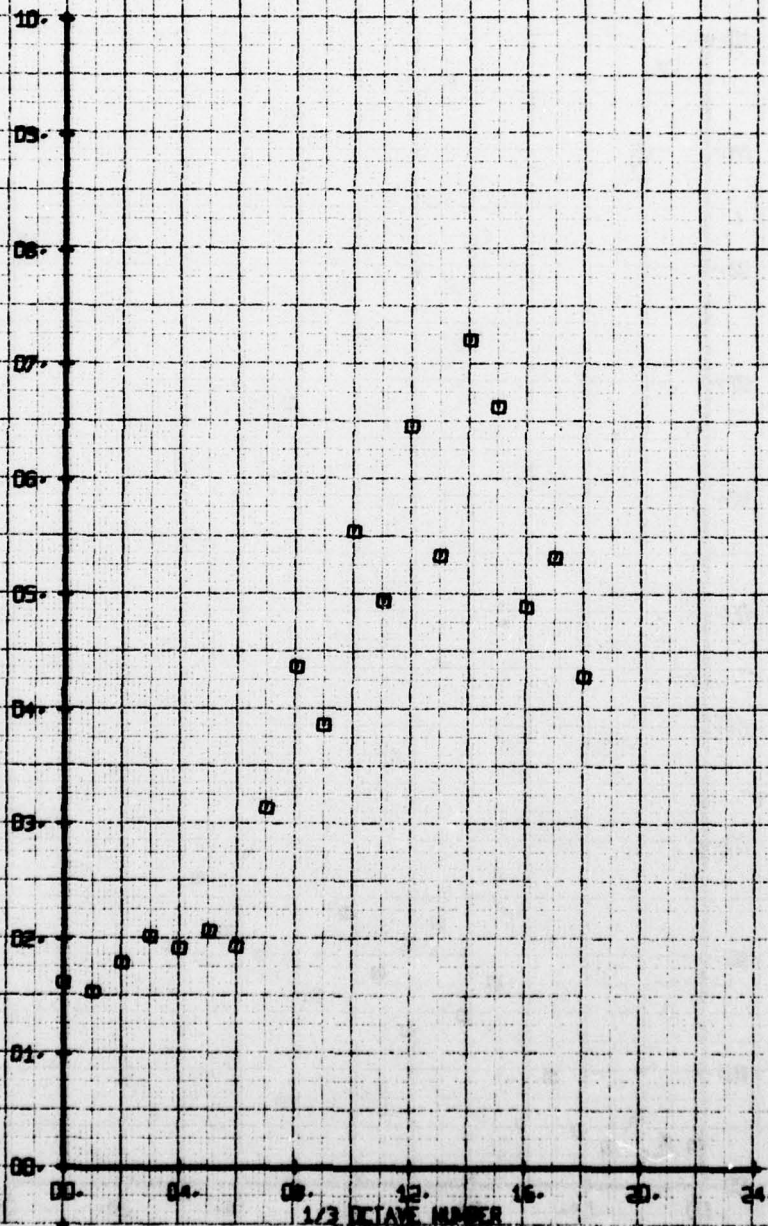
HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 155 TP 3

SYM  
 □

CN  
 65

LEGEND  
 PARAMETER  
 BETA

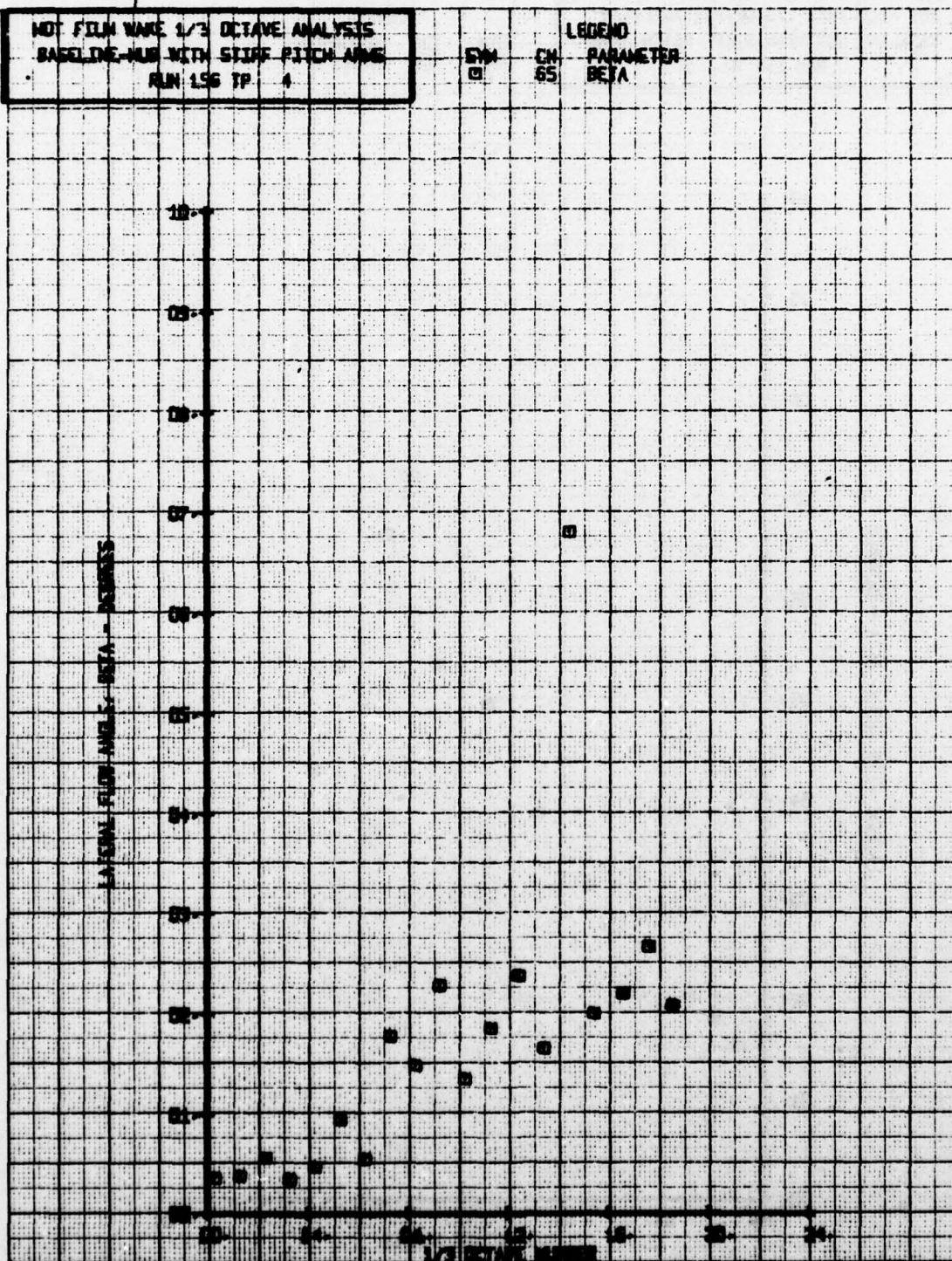
LATERAL FLOW ANGLE, BETA - DEGREES





NOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-MUD WITH STIFF PITCH ARM  
 RUN 156 TP 4

LEGEND  
 CH 65  
 PARAMETER  
 BETA

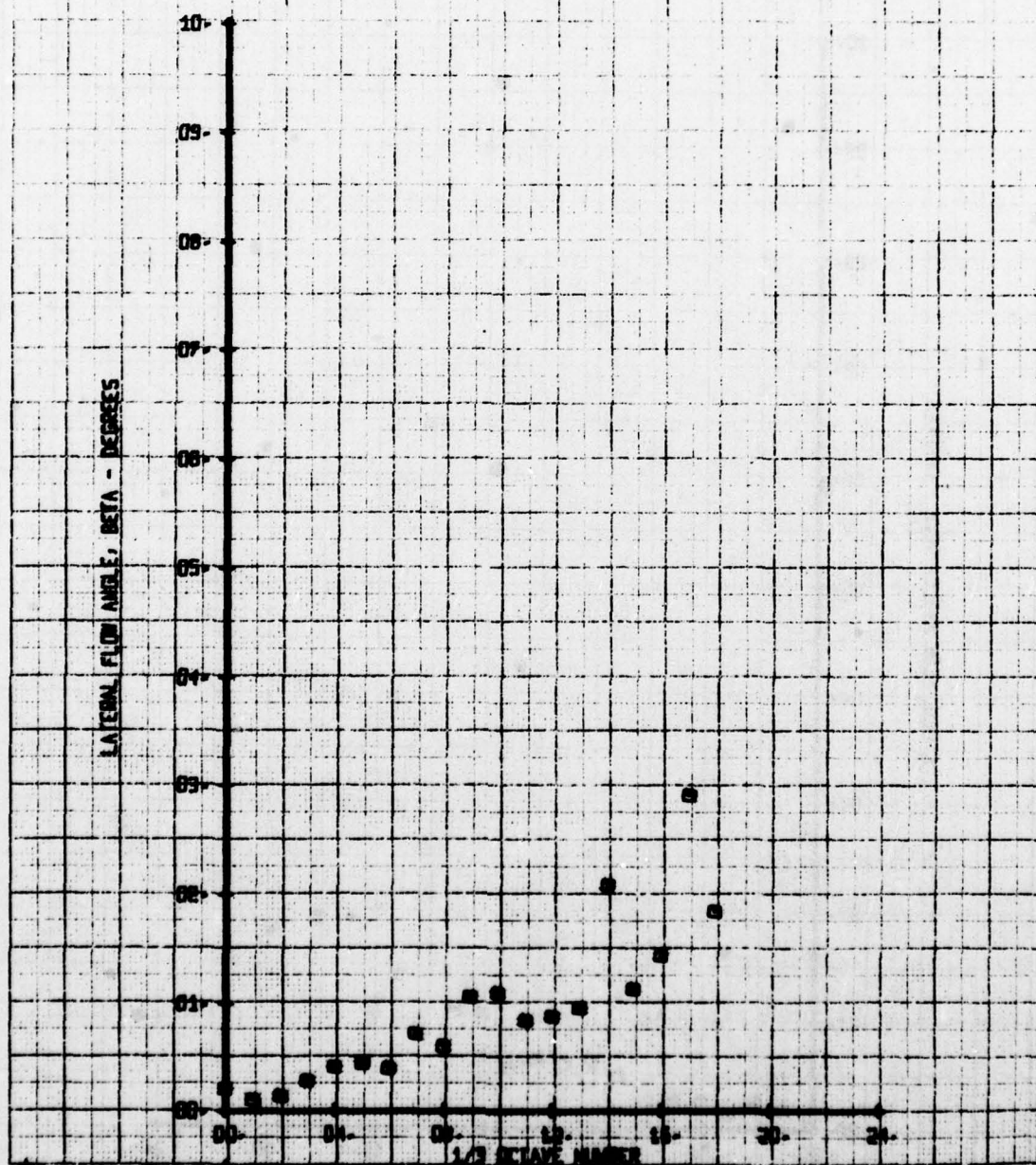


HOT FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 156 TP 5

SYM  
 0

CH  
 65

LEGEND  
 PARAMETER  
 BETA





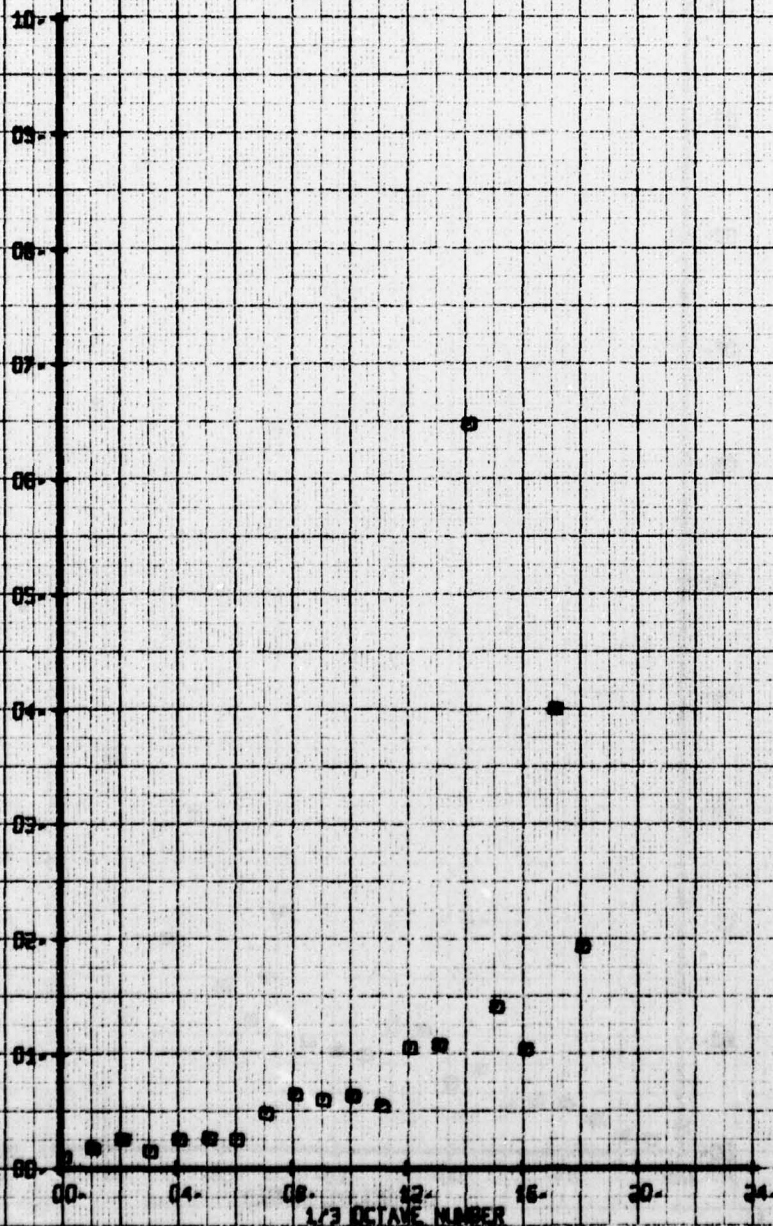
NOT FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE-448 WITH STIFF FITCH APMS  
 RUN 156 TP 6

SYM  
 8

CM  
 65

LEGEND  
 PARAMETER  
 BETA

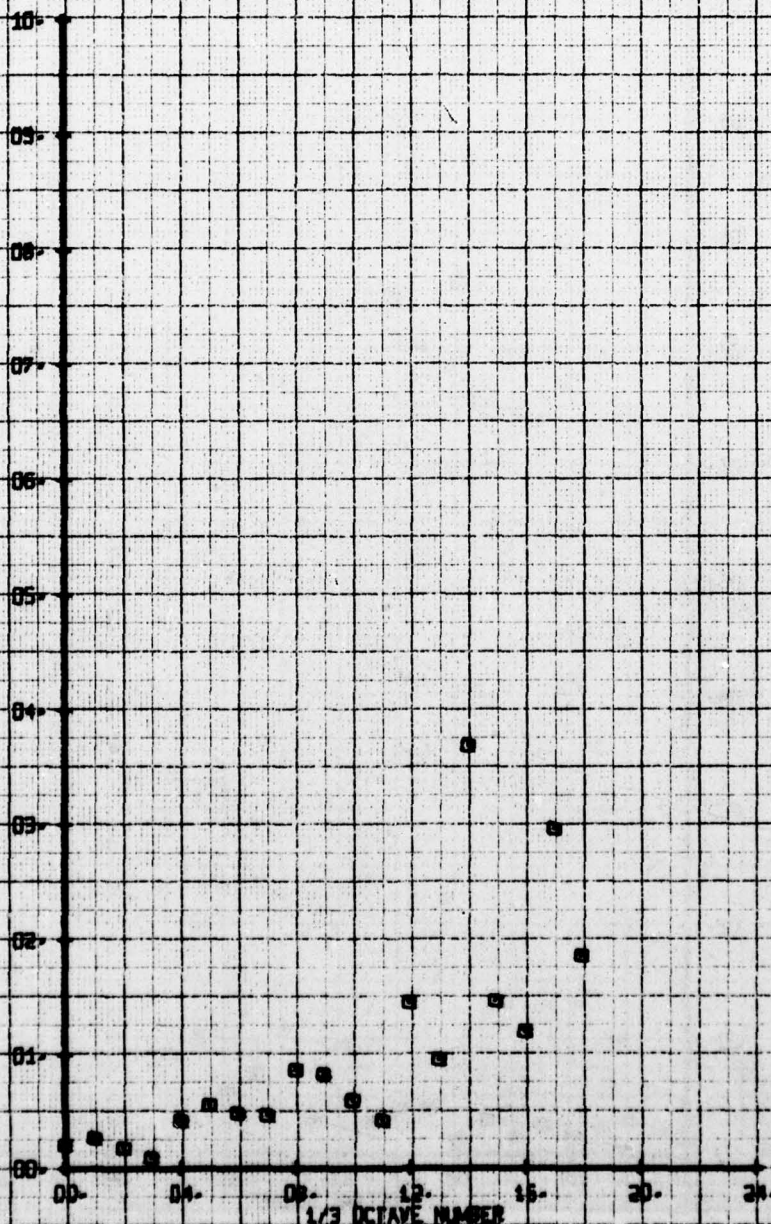
LATERAL FLOW ANGLE F. BETA - DEGREES



NOT FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 156 TP 7

SYN CH  
 65 65  
 PARAMETER  
 BETA

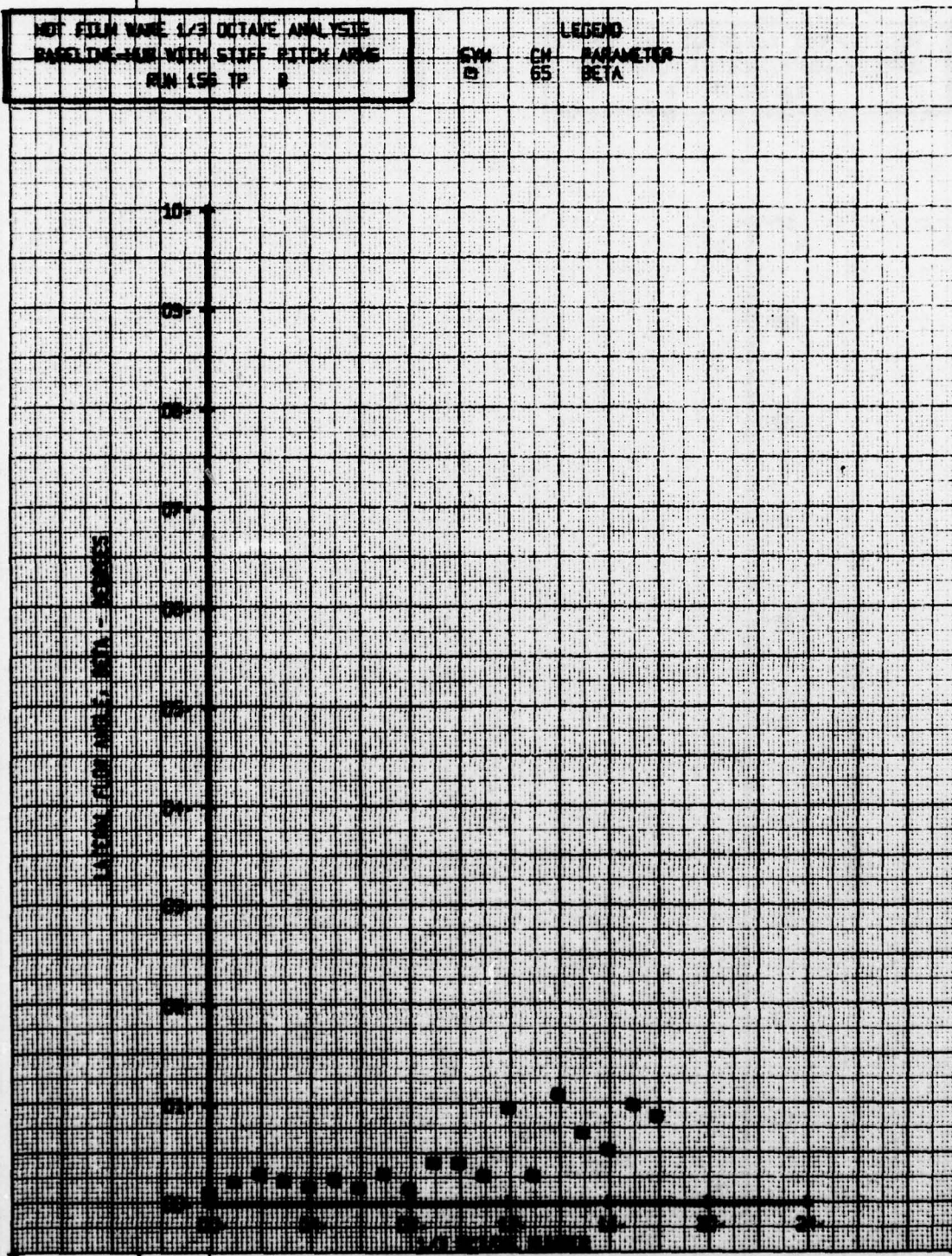
LATERAL FLOW ANGLE: BETA - DEGREES





NET FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE RUN WITH STIFF PITCH ARMS  
 RUN 156 TP 8

SYN CH PARAMETER  
 0 65 BETA

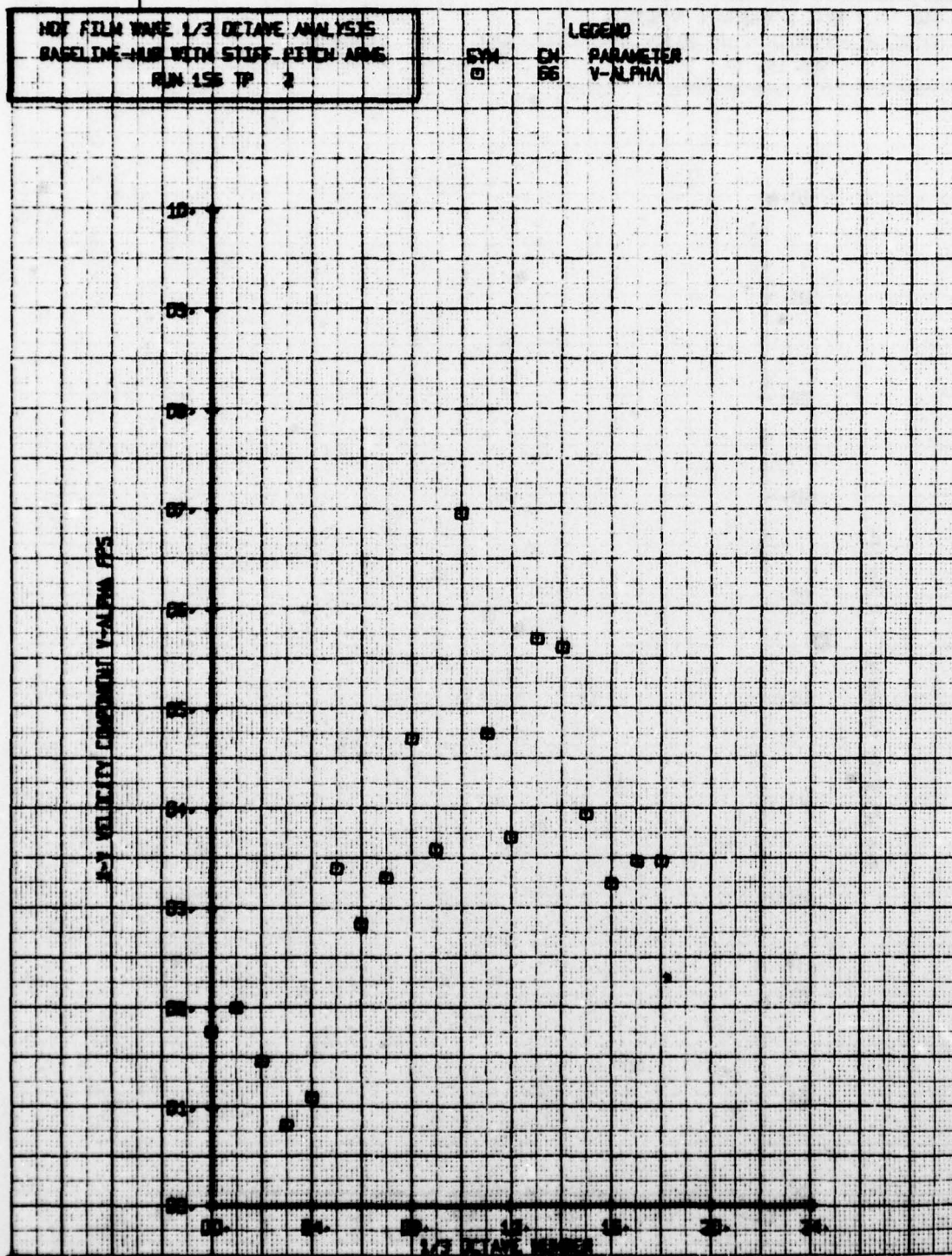


NOI FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 156 TP 2

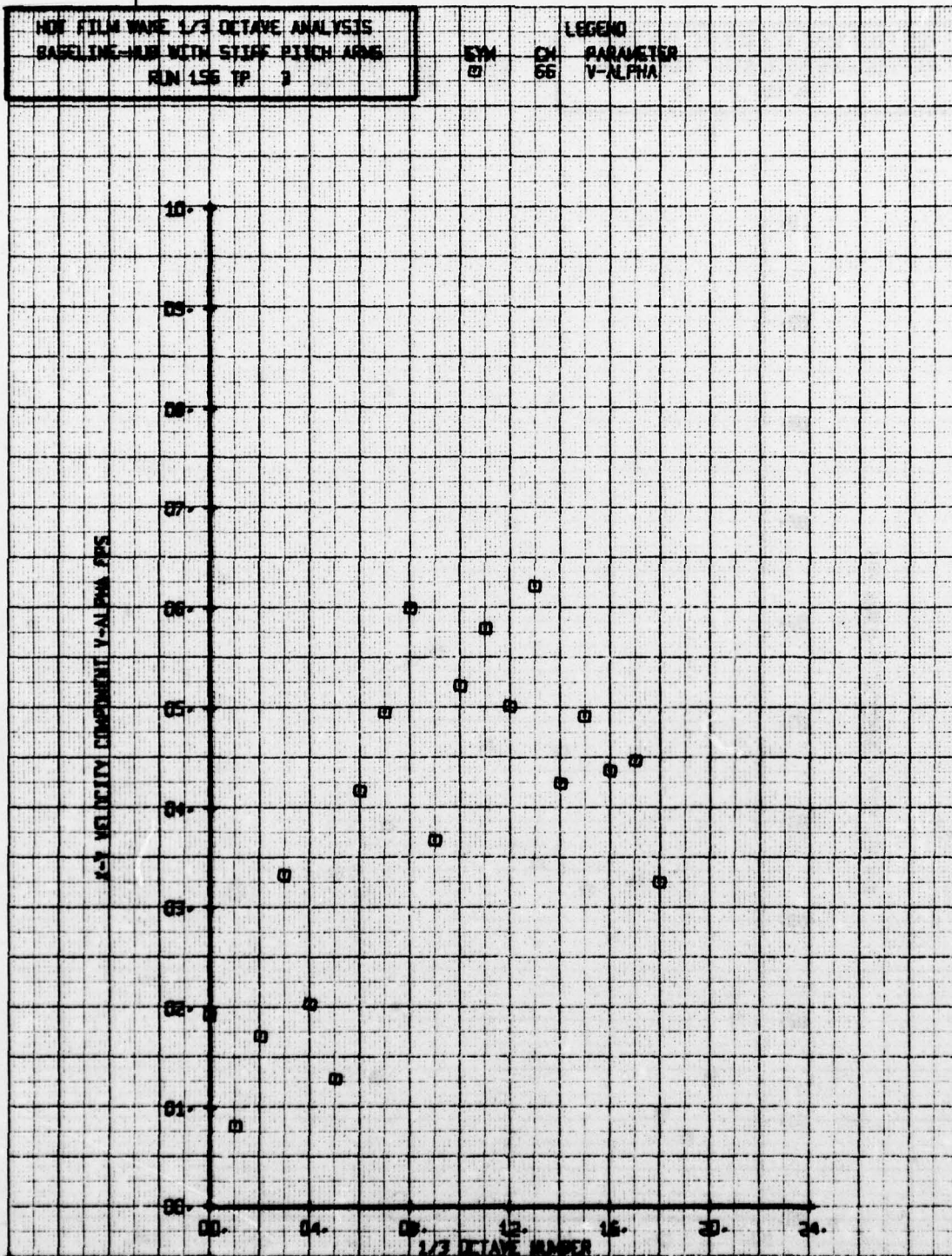
SYM  
 □

CM  
 56

LEGEND  
 PARAMETER  
 V-ALPHA



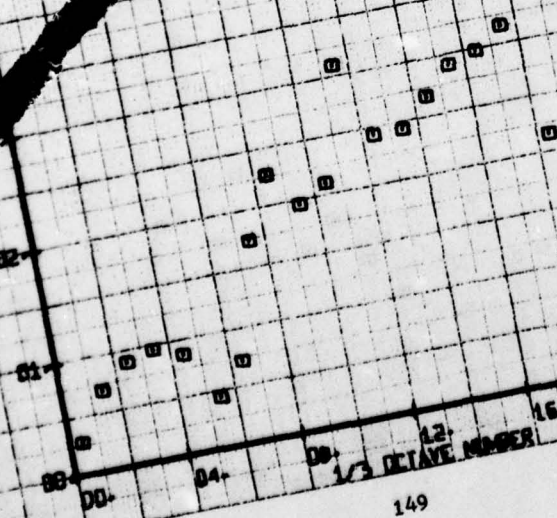




HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-MUB WITH STIFF PITCH ARMS  
 RUN 156 TP 4

CH 66  
 LEGEND  
 PARAMETER  
 V-ALPHA

X-1 VELOCITY COMPONENT V-ALPHA FPS

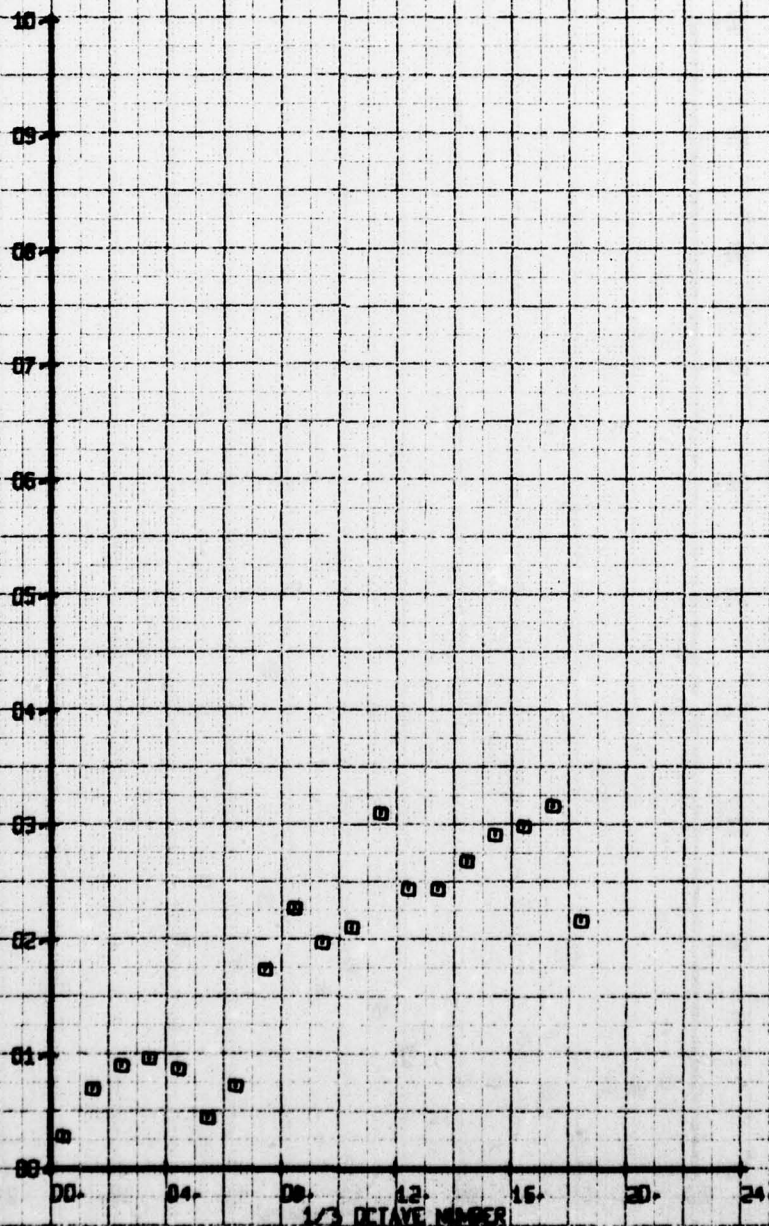




HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 156 TP 4

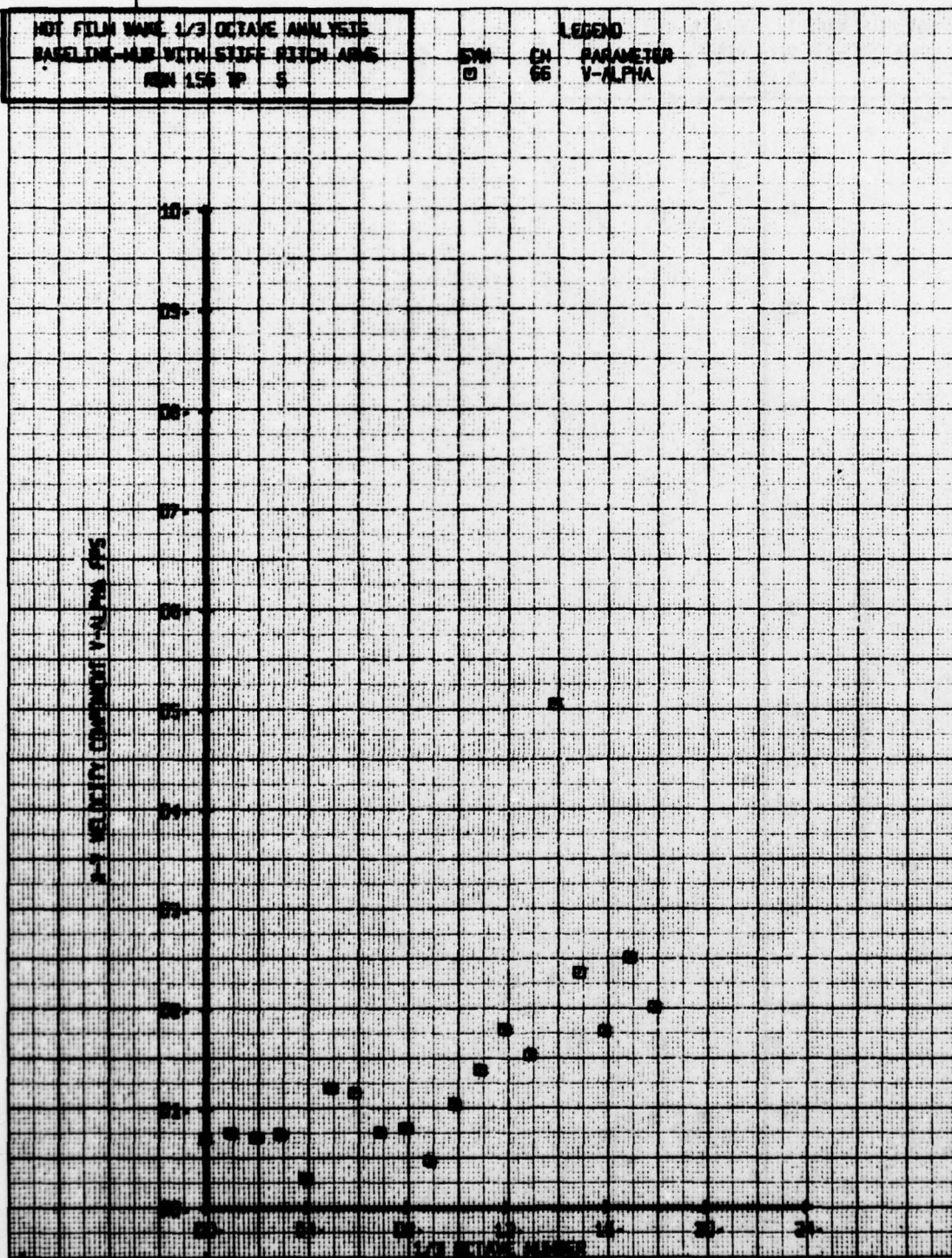
LEGEND  
 CH 66 PARAMETER  
 V-ALPHA

X-Y VELOCITY COMPONENT V-ALPHA FPS



HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-MAP WITH STIFF FITCH ARMS  
 RUN 156 TP S

SYN CH  
 01 66  
 V-ALPHA





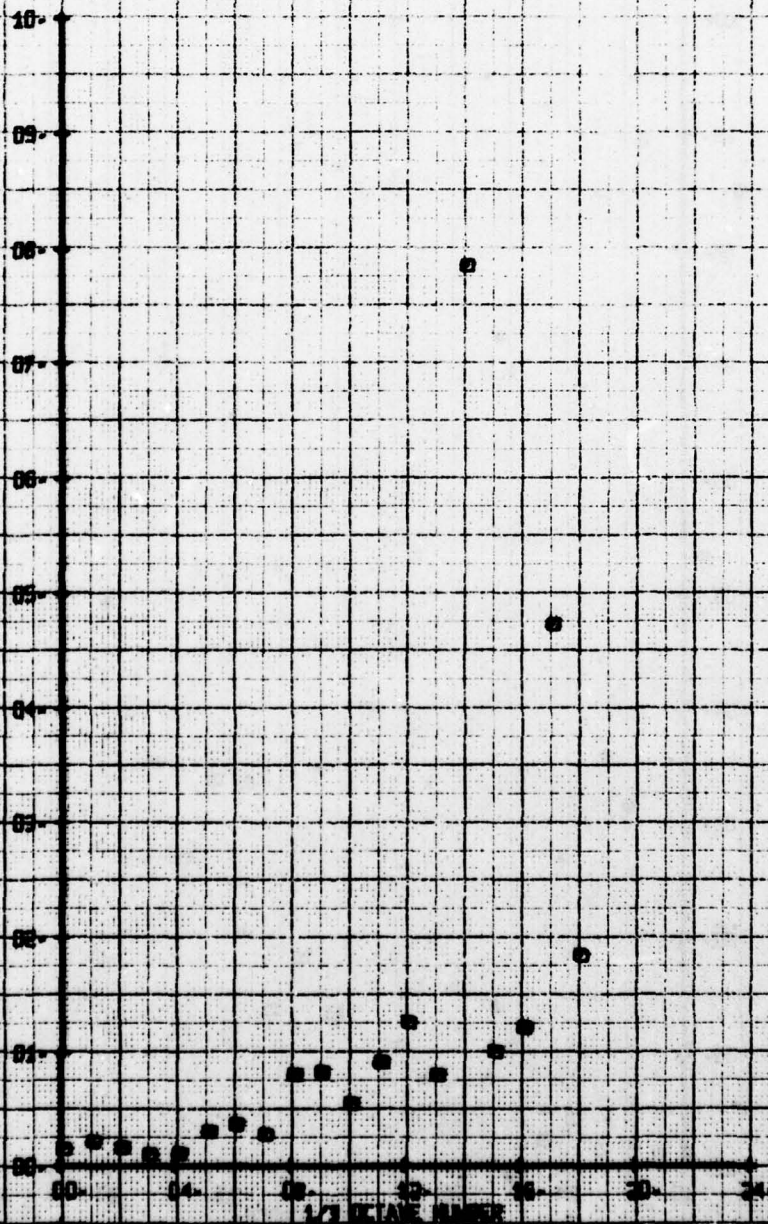
HOT FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 156 TP 6

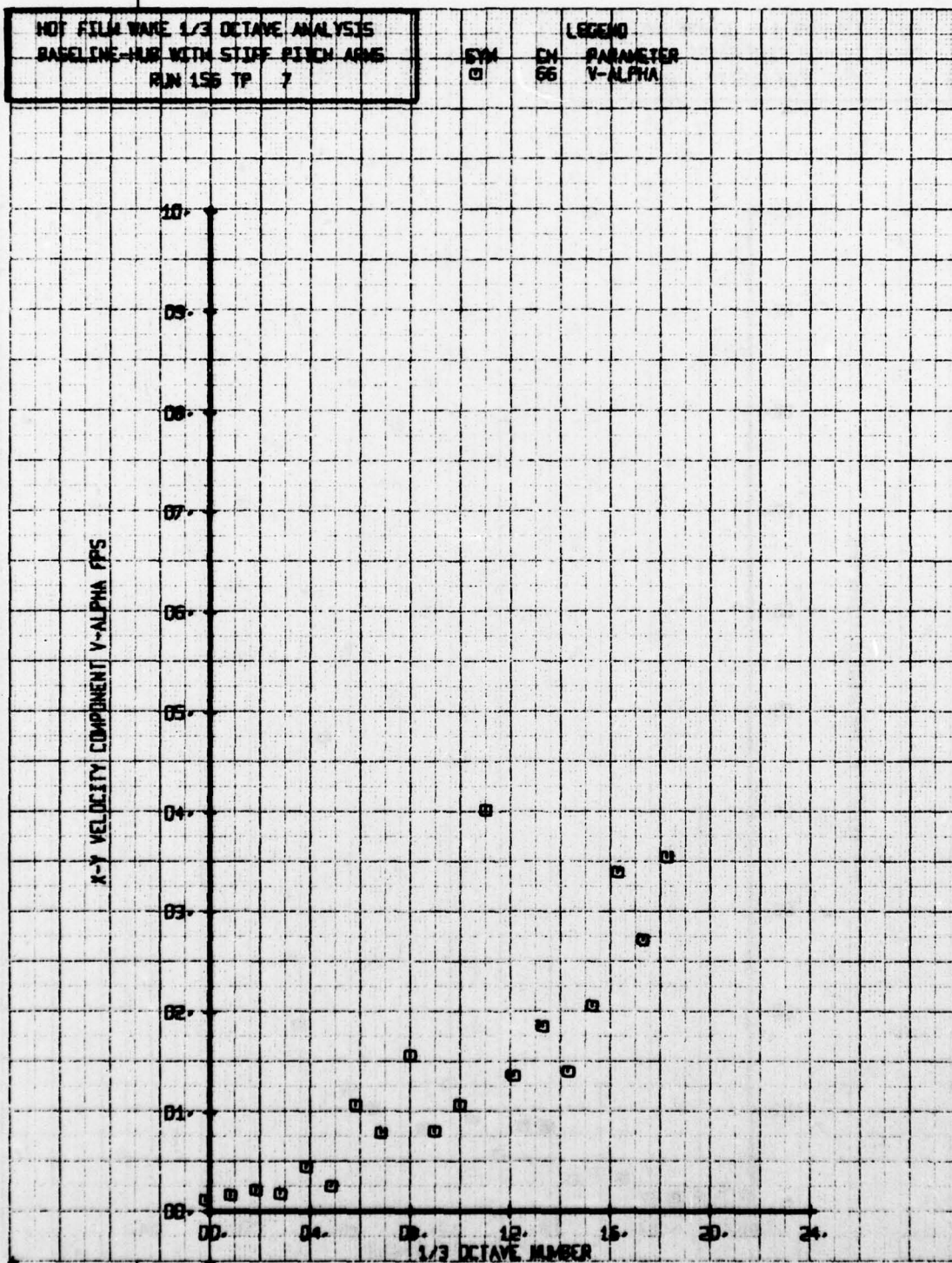
SYM  
 0

CN  
 66

LEGEND  
 PARAMETER  
 V-ALPHA

1-2 RELATIVE COEFFICIENT V-ALPHA RMS



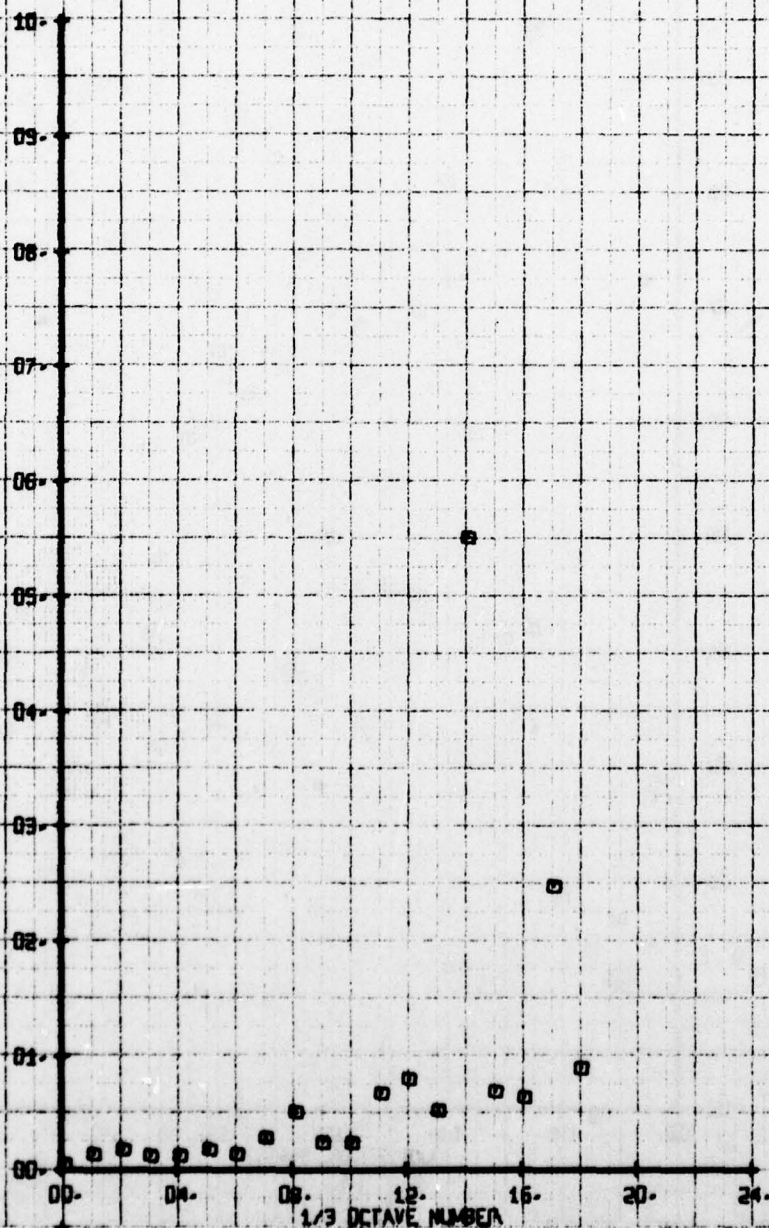




HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE HUB WITH STIFF PITCH ARMS  
 RUN 156 TP 8

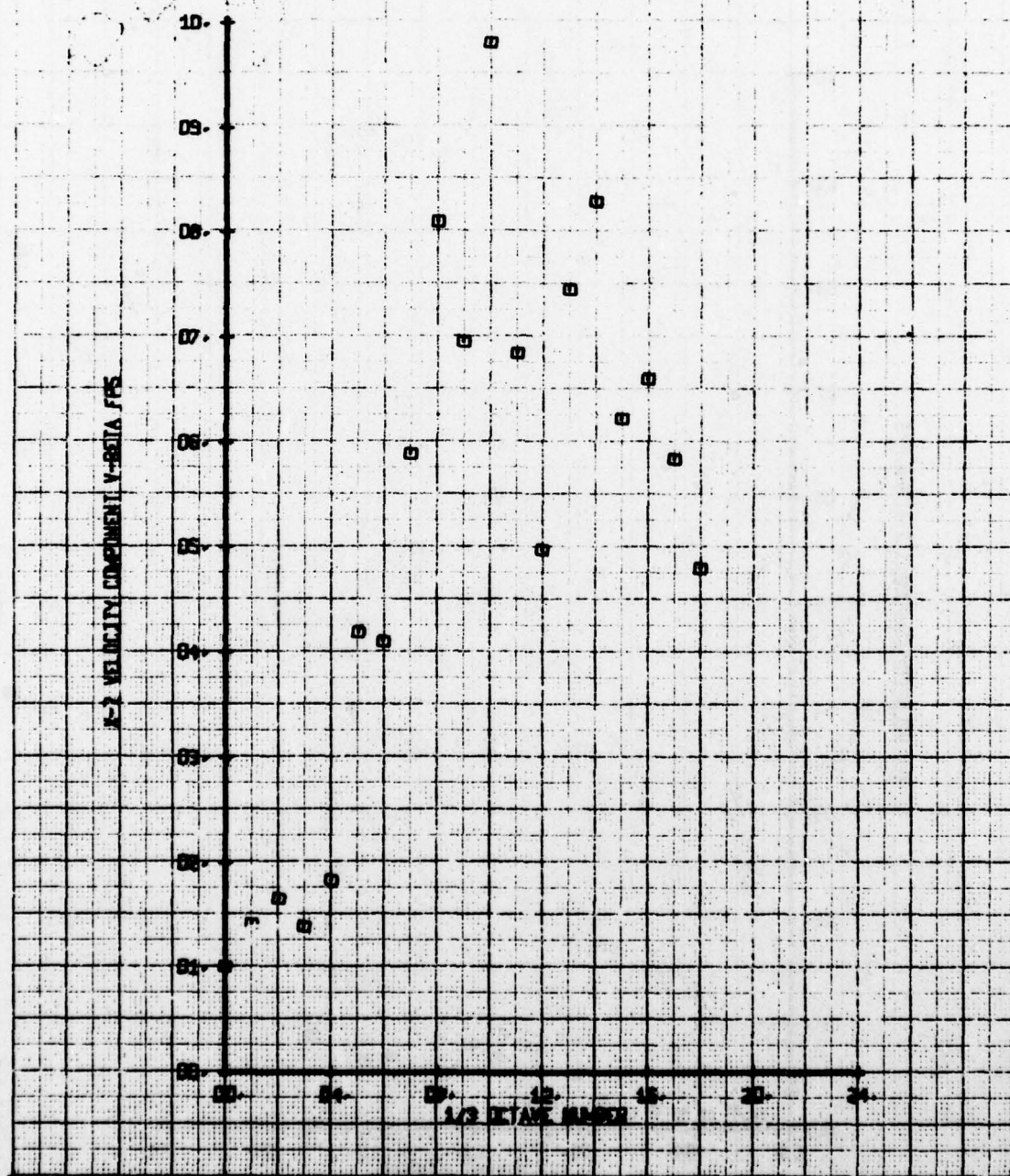
SYN CH  
 66 66  
 LEGEND  
 PARAMETER  
 V-ALPHA

1-1 VELOCITY COMPONENT V-ALPHA FPS



HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 196 TP 2

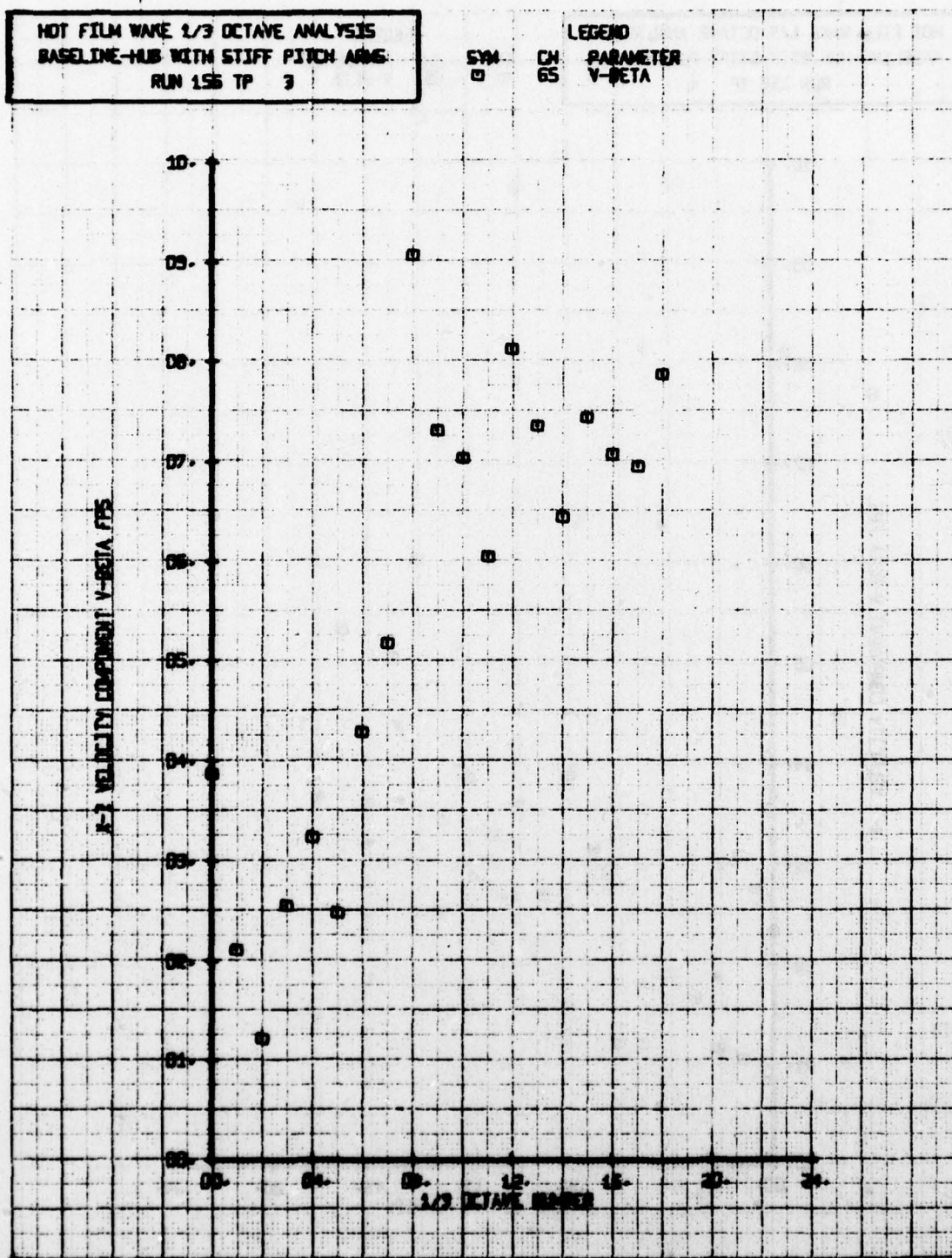
LEGEND  
 SYM CH PARAMETER  
 □ 65 V-BETA

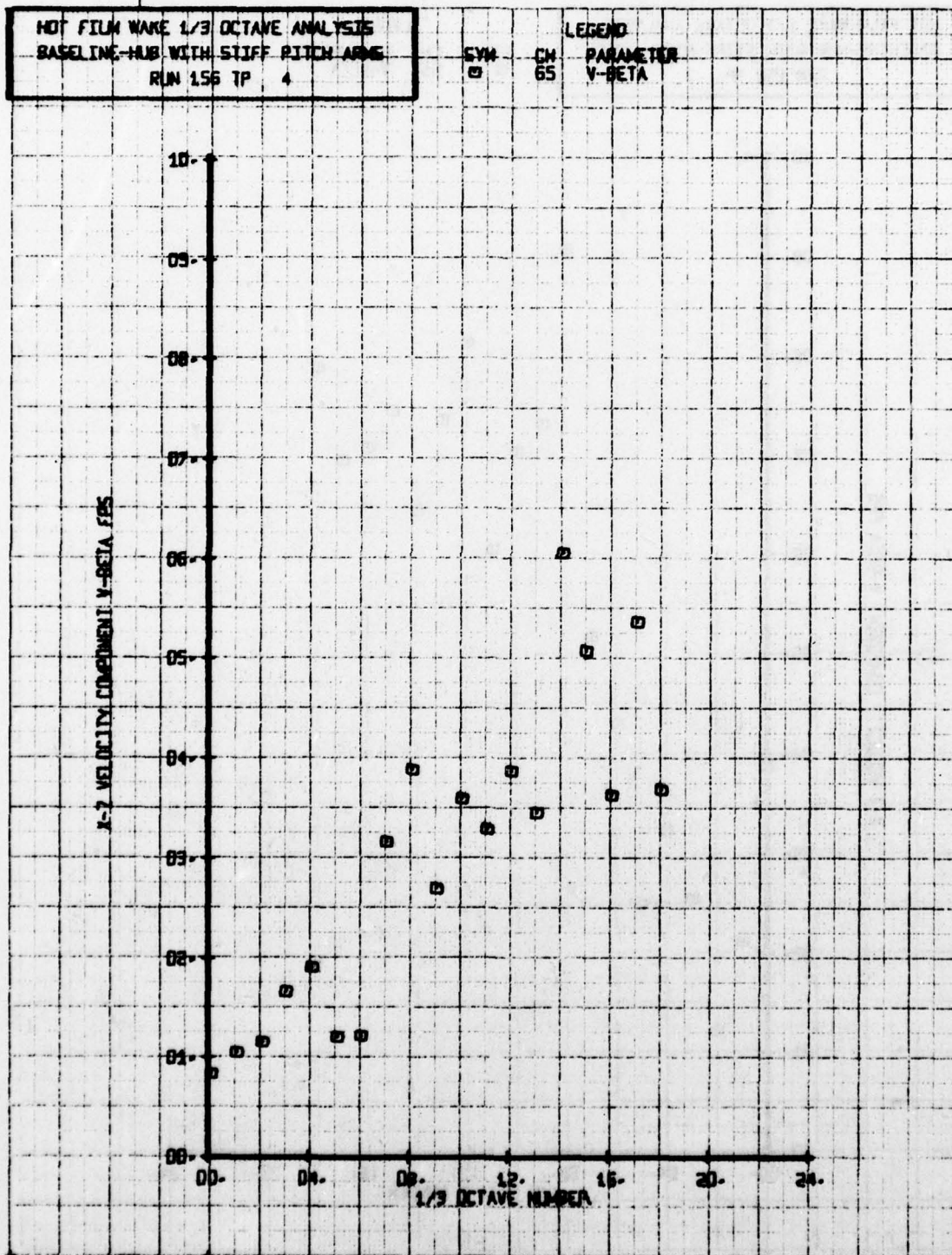




HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 155 TP 3

SYN CH  
 65 65  
 LEGEND  
 PARAMETER  
 V-BETA

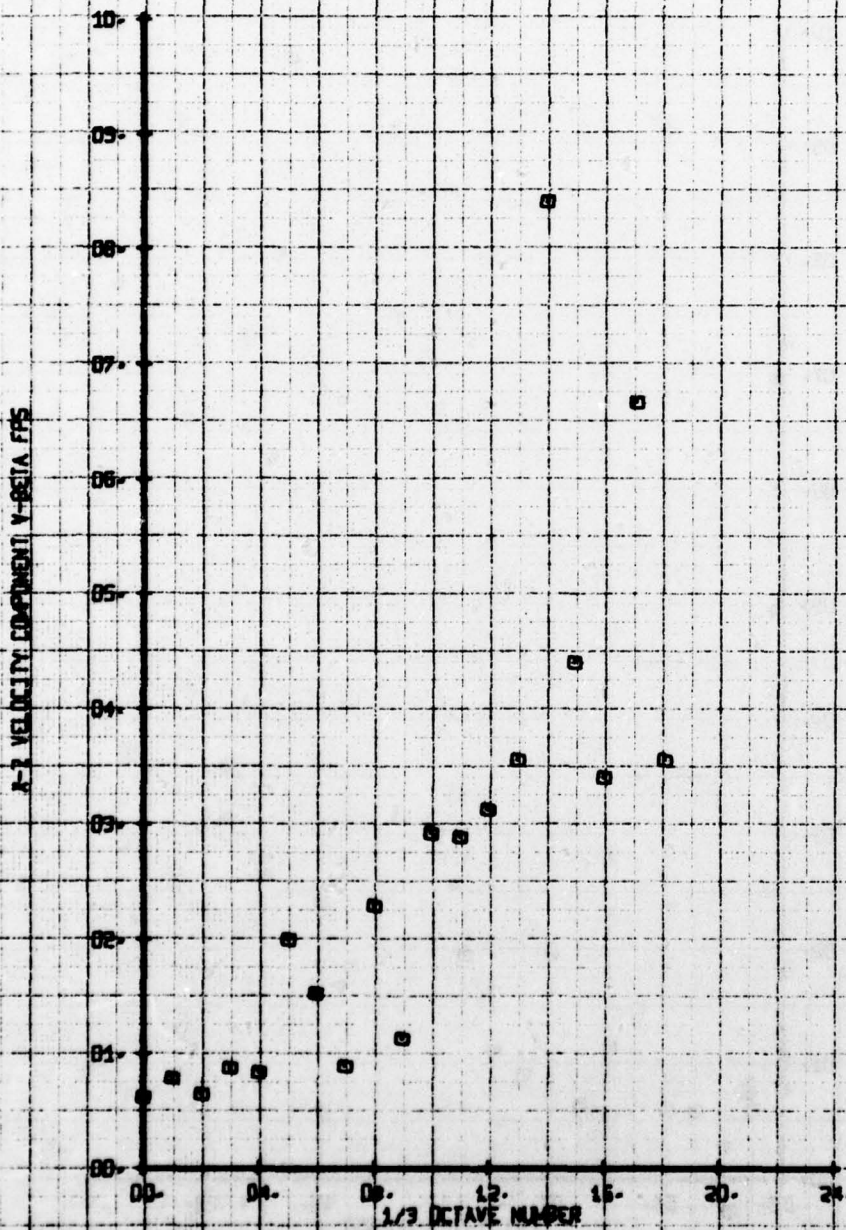






HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 156 TP 5

SYM CH PARAMETER  
 □ 65 V-BETA



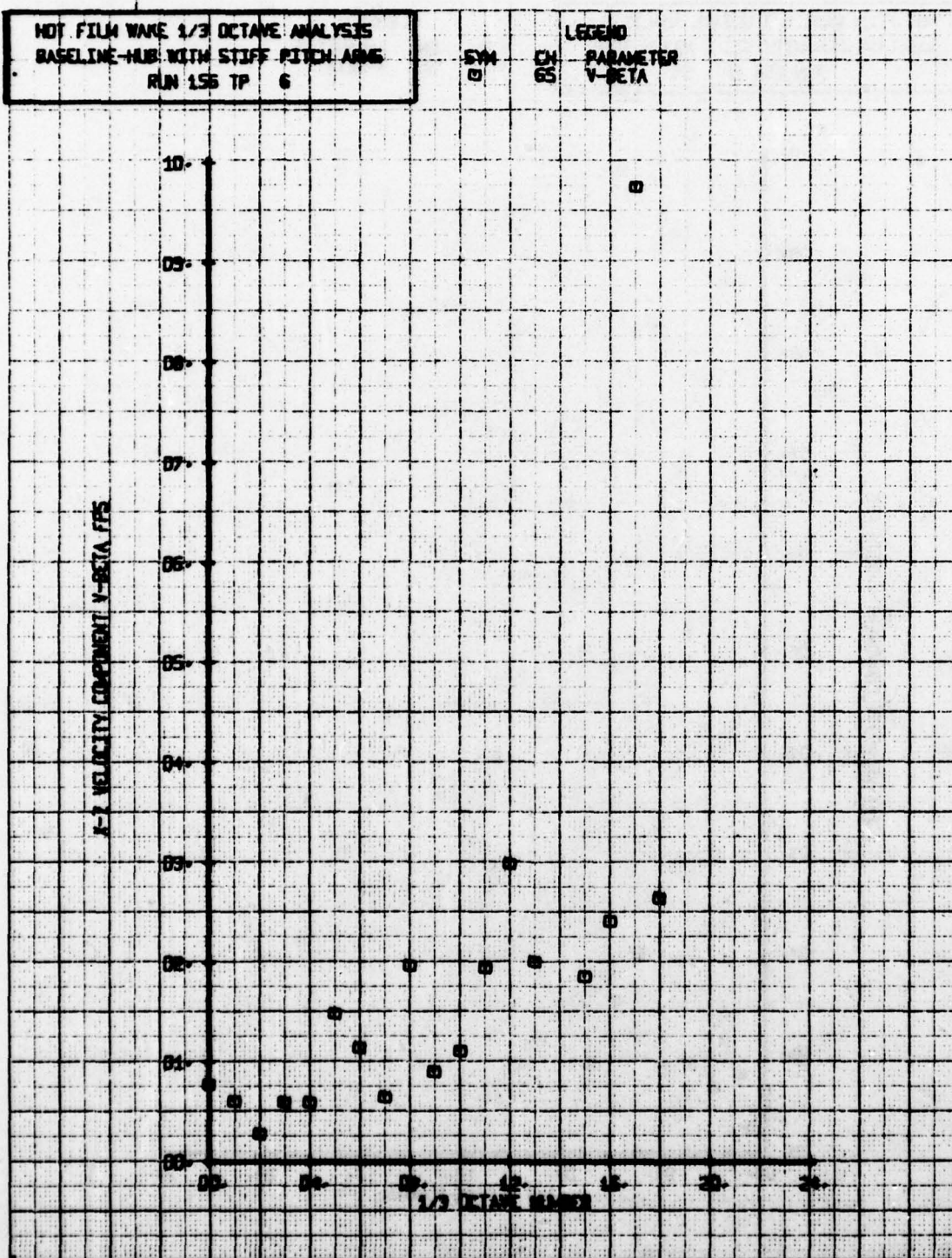
HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 156 TP 6

SYM  
 □

CH  
 65

LEGEND  
 PARAMETER  
 V-BETA

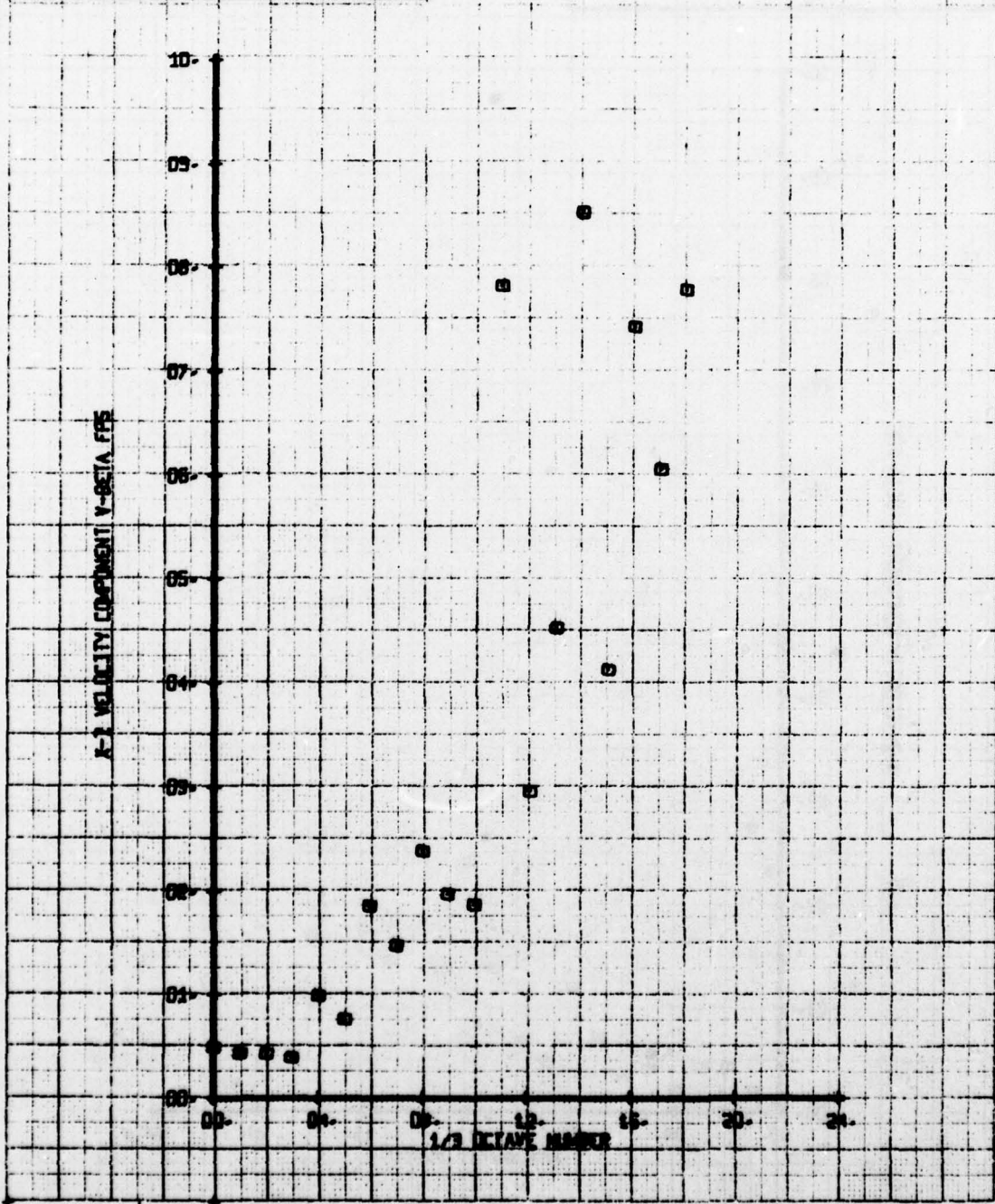
K-1 VELOCITY COMPONENT V-BETA FPS





HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE-HUB WITH STIFF PITCH ARMS  
 RUN 156 TP 7

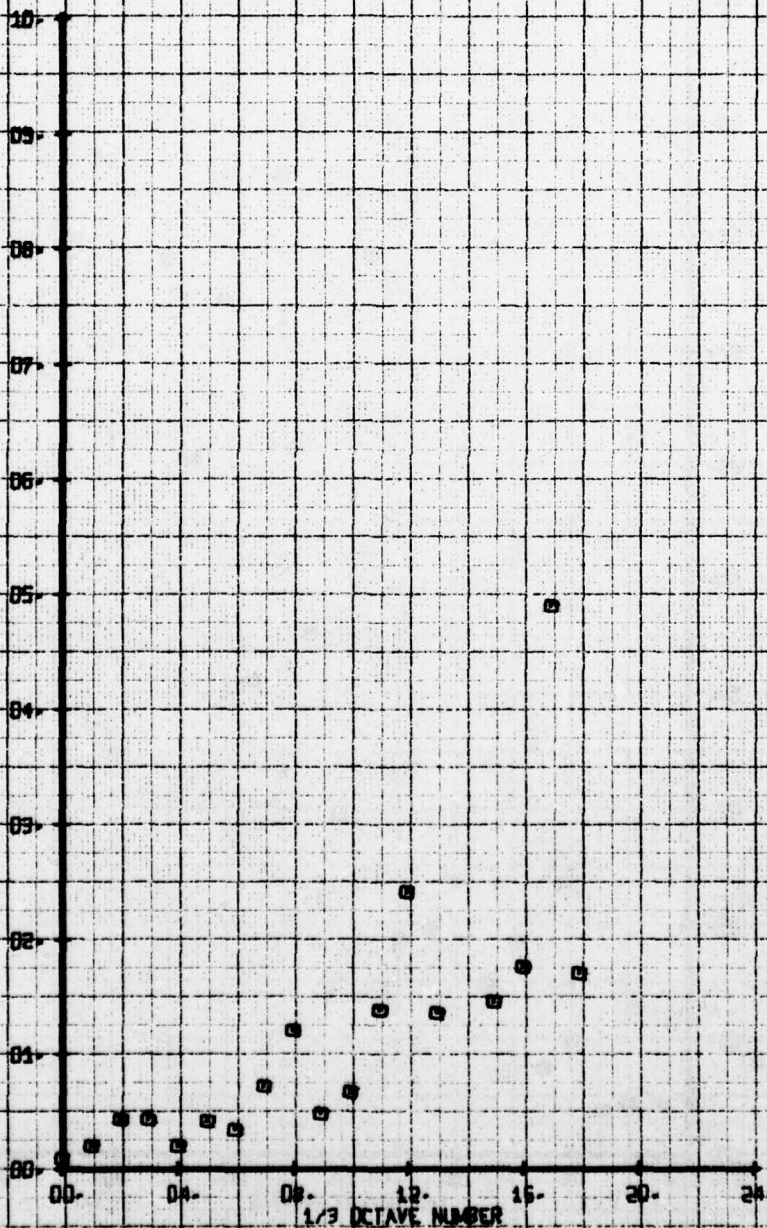
SYN CH PARAMETER  
 □ 65 V-BETA



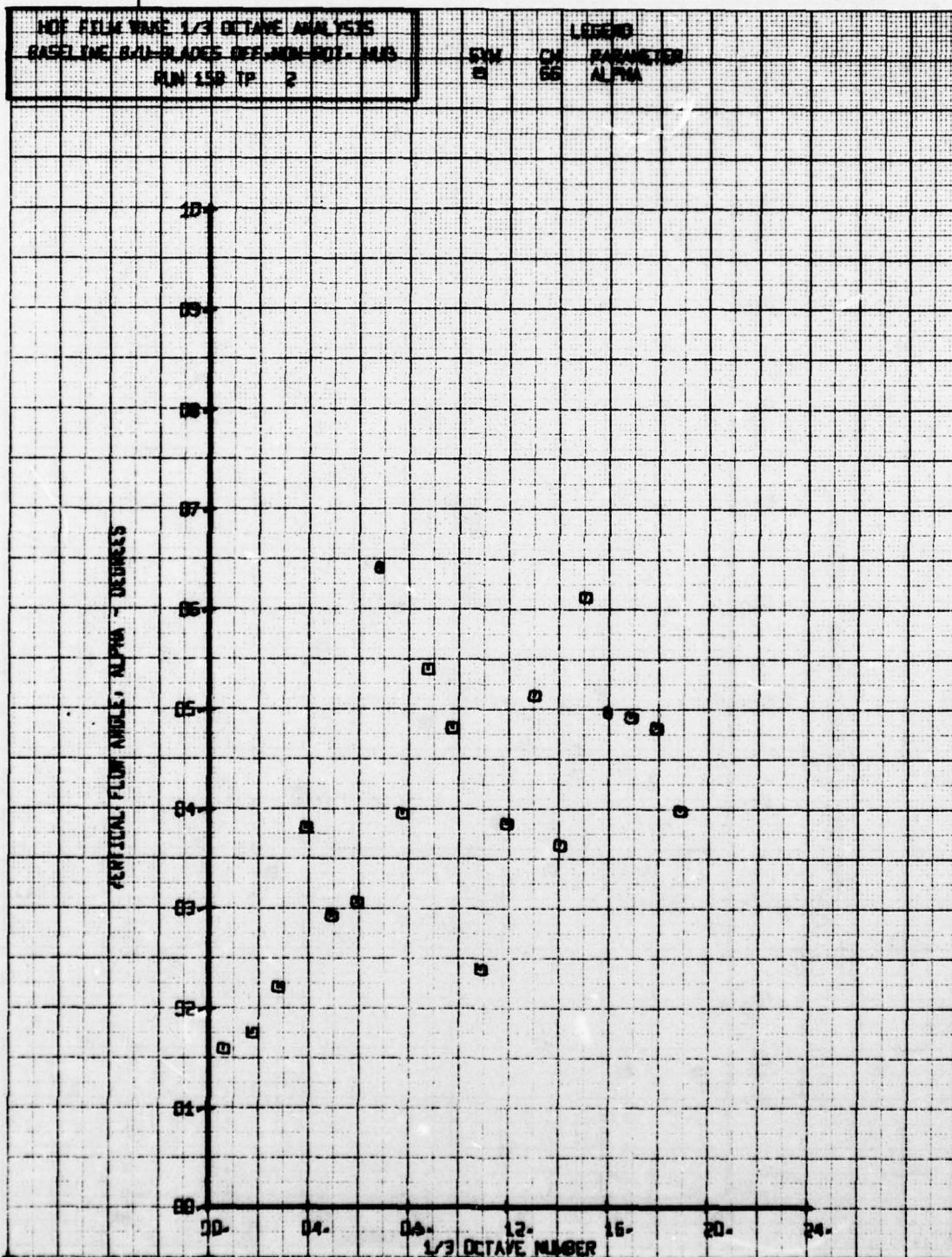
HOT FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE-NUM WITH STIFF PITCH ARM  
 RUN 156 TP 8

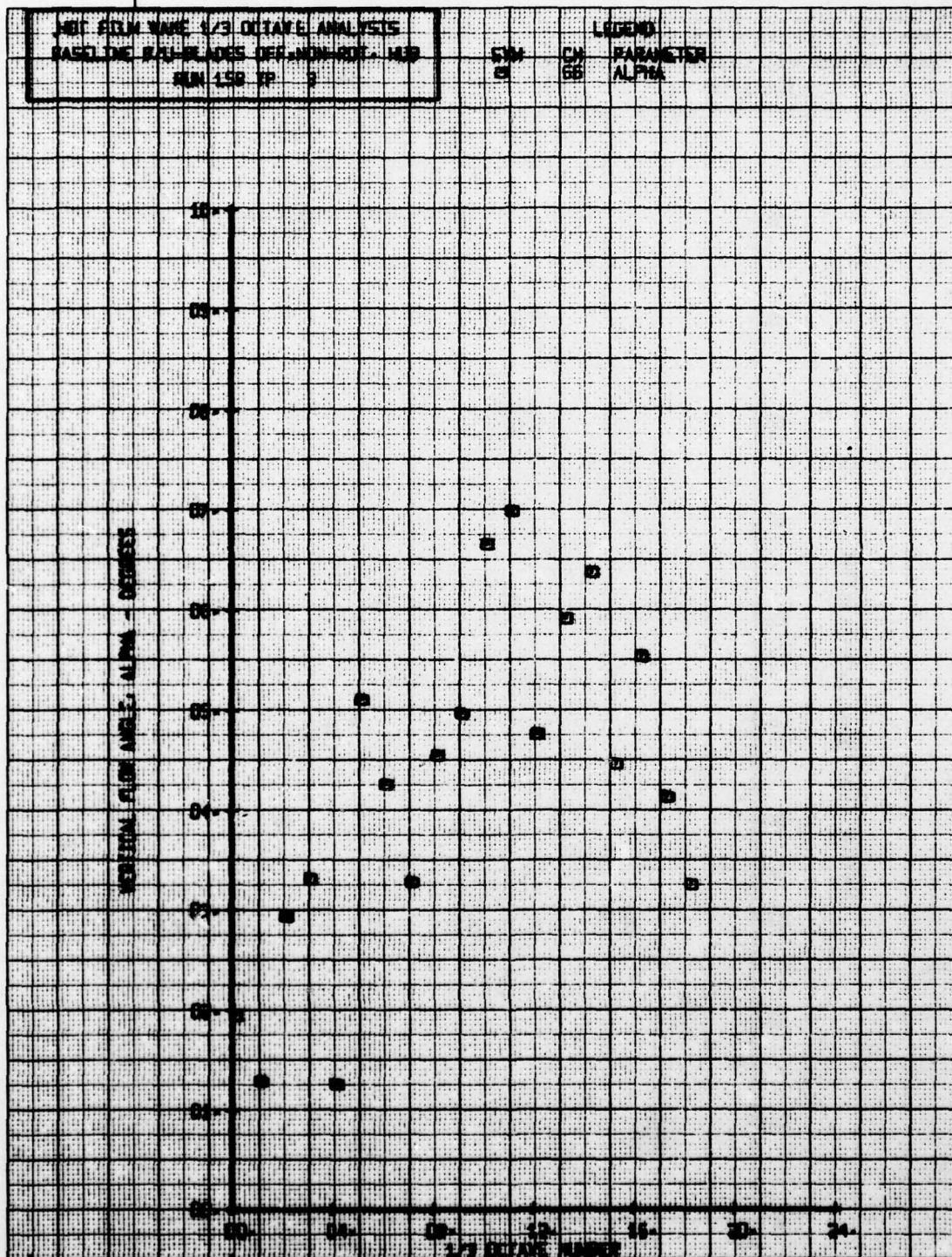
SYM CH PARAMETER  
 □ 65 V-BETA

X-Z VELOCITY COMPONENT V-BETA FPS



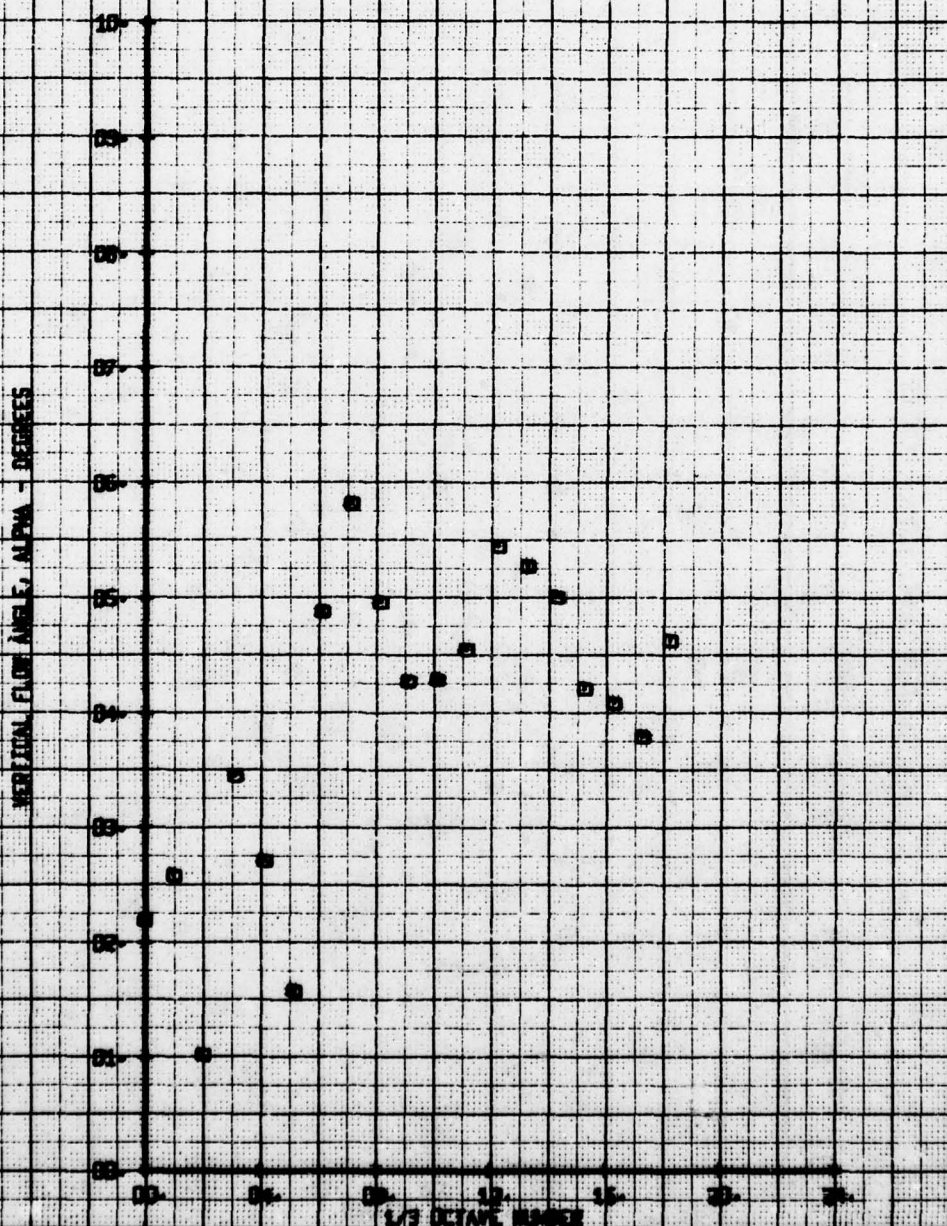


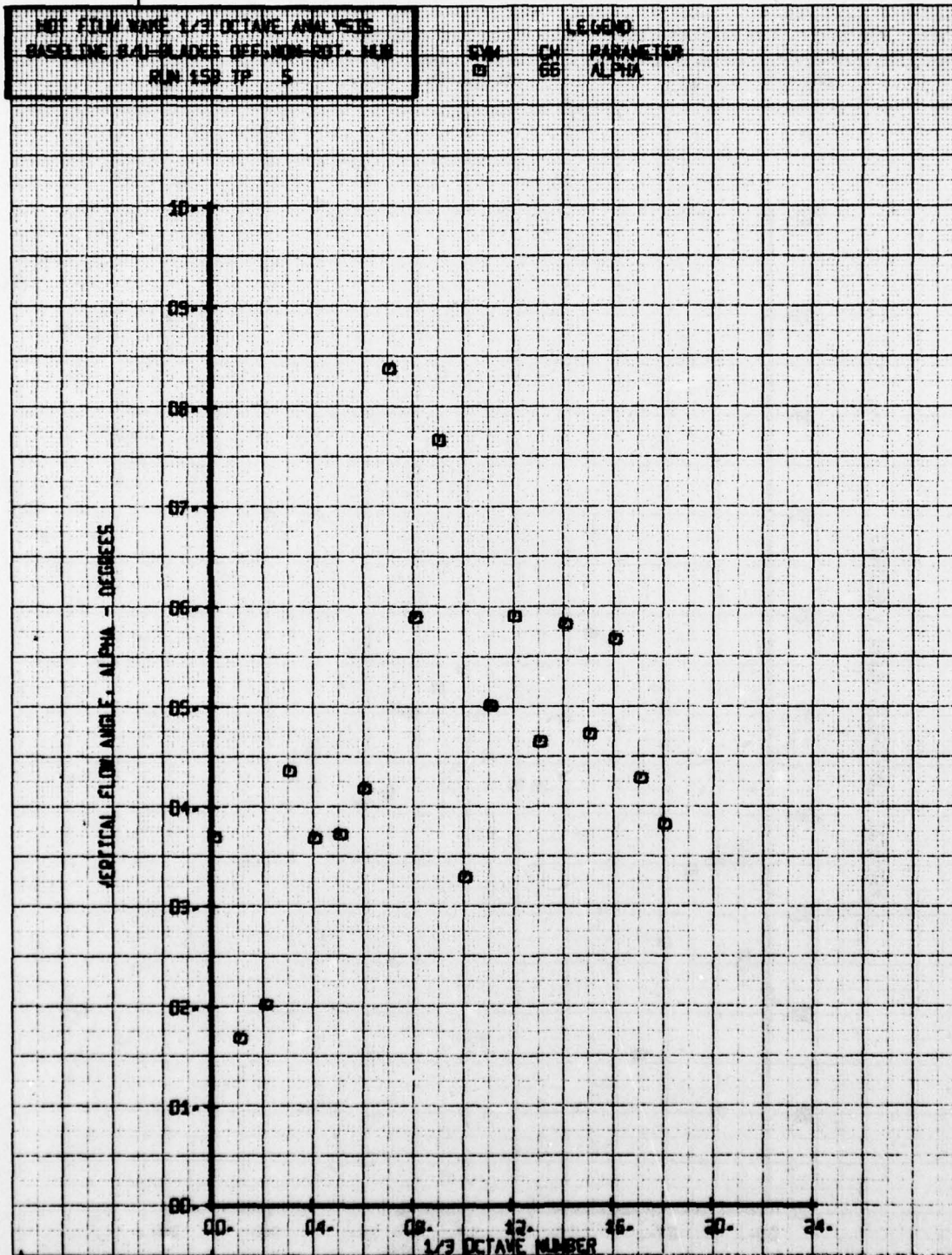






LEGEND	
CH	PARAMETER
DS	ALPHA

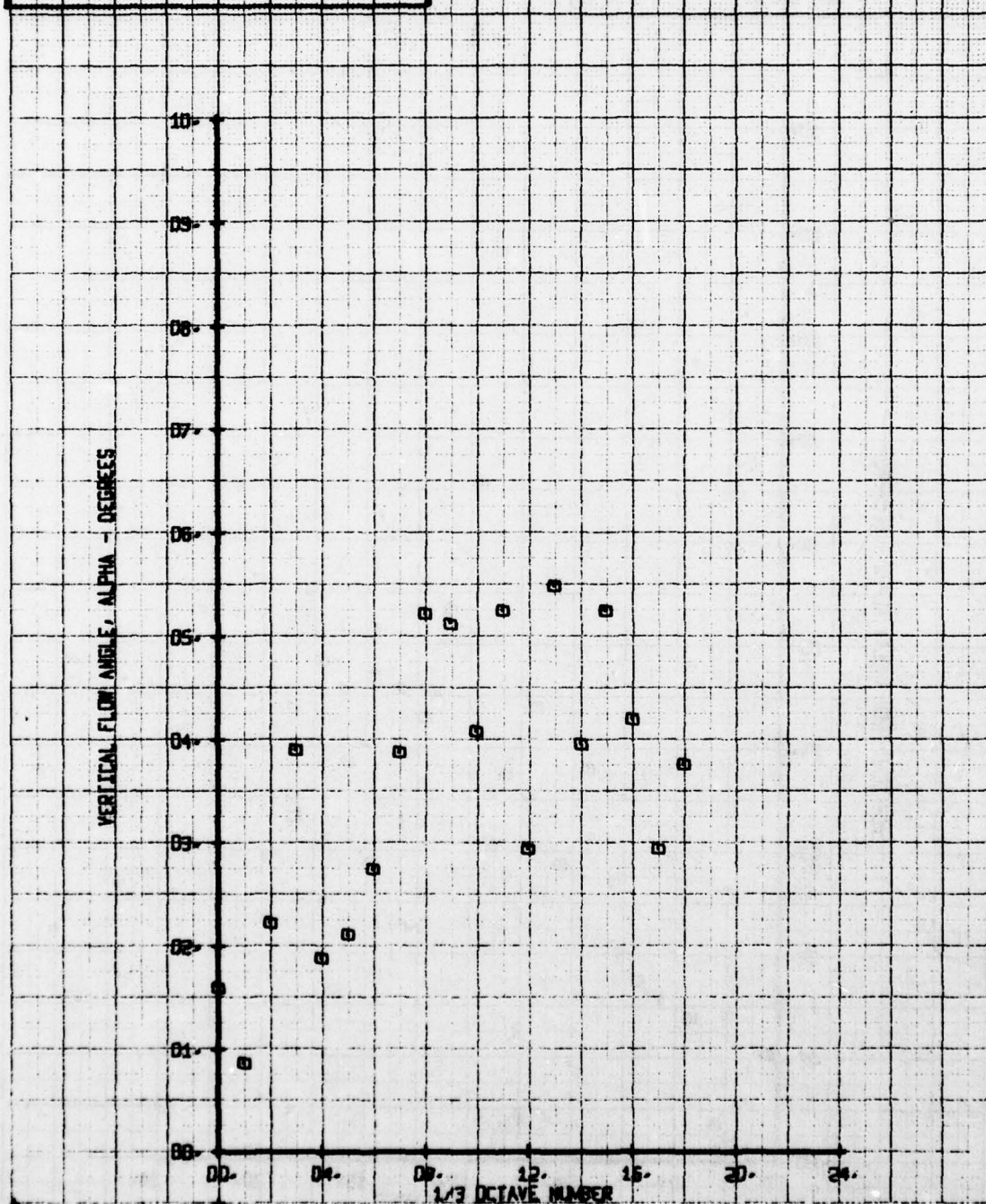




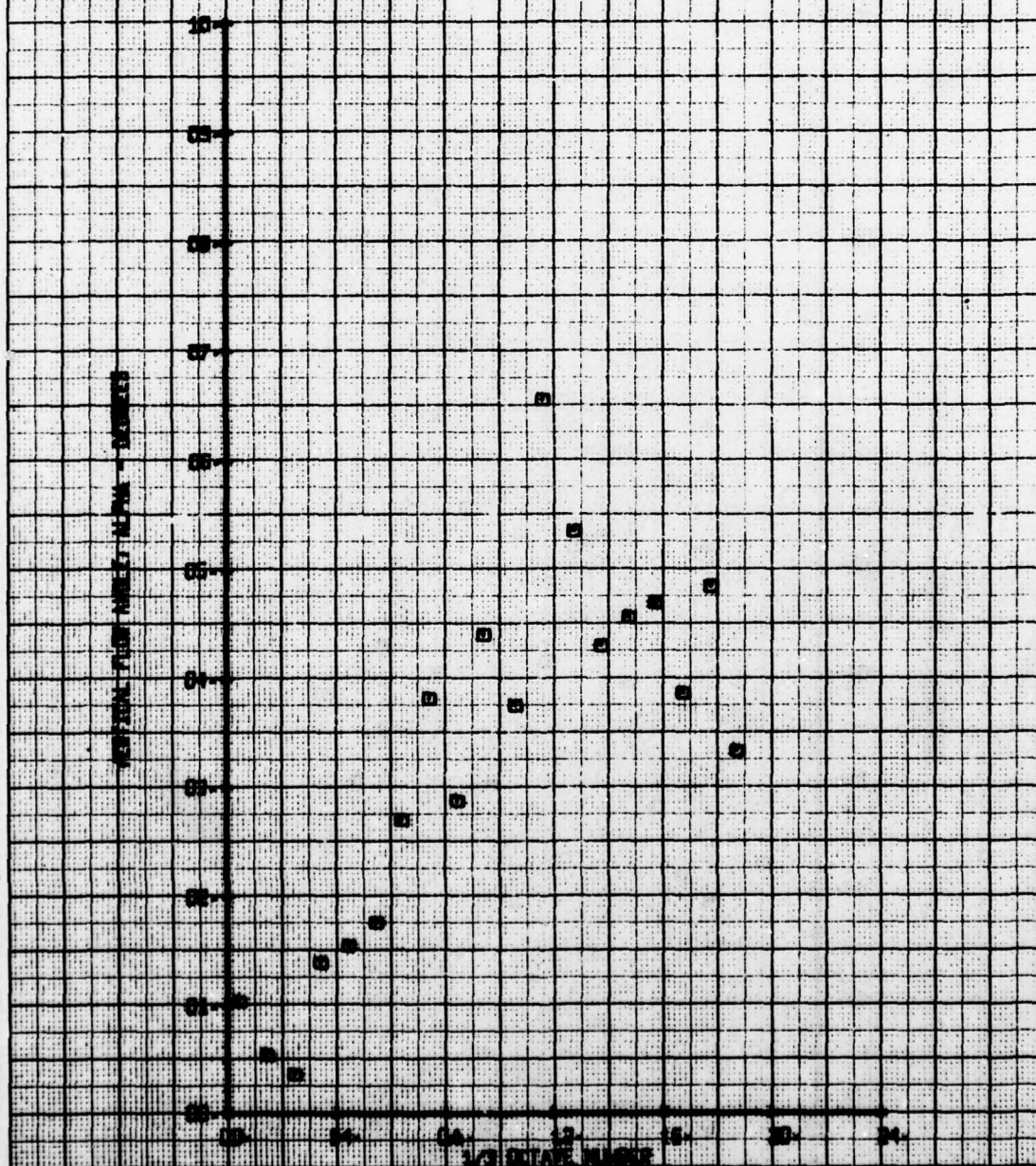


NOT FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE 8/40 BLADES OFF, NON-ROT. MIN  
 RUN 158 TP 6

SYN CH  
 6 66  
 PARAMETER  
 ALPHA



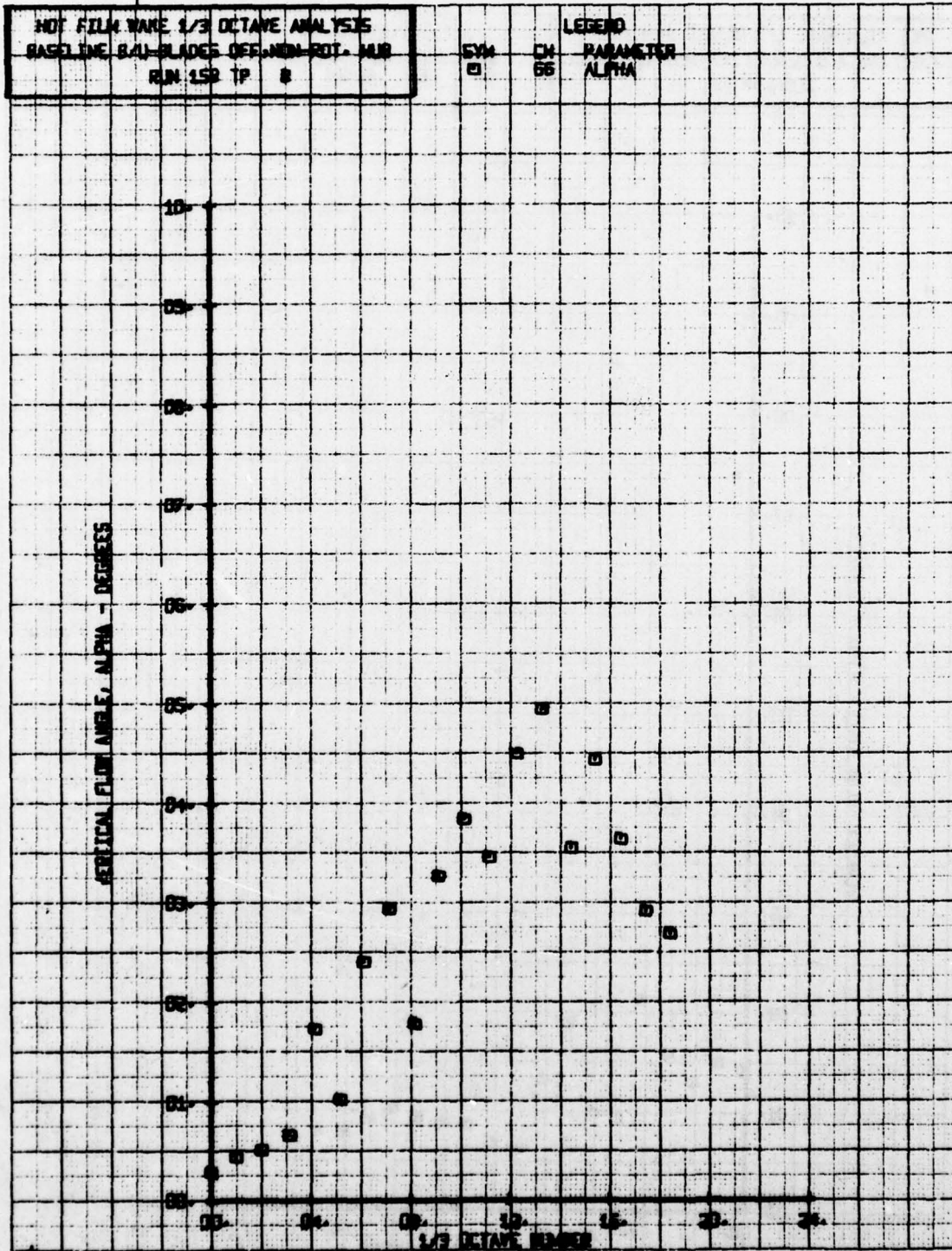
LIMITED  
 BANGOR  
 ALFA

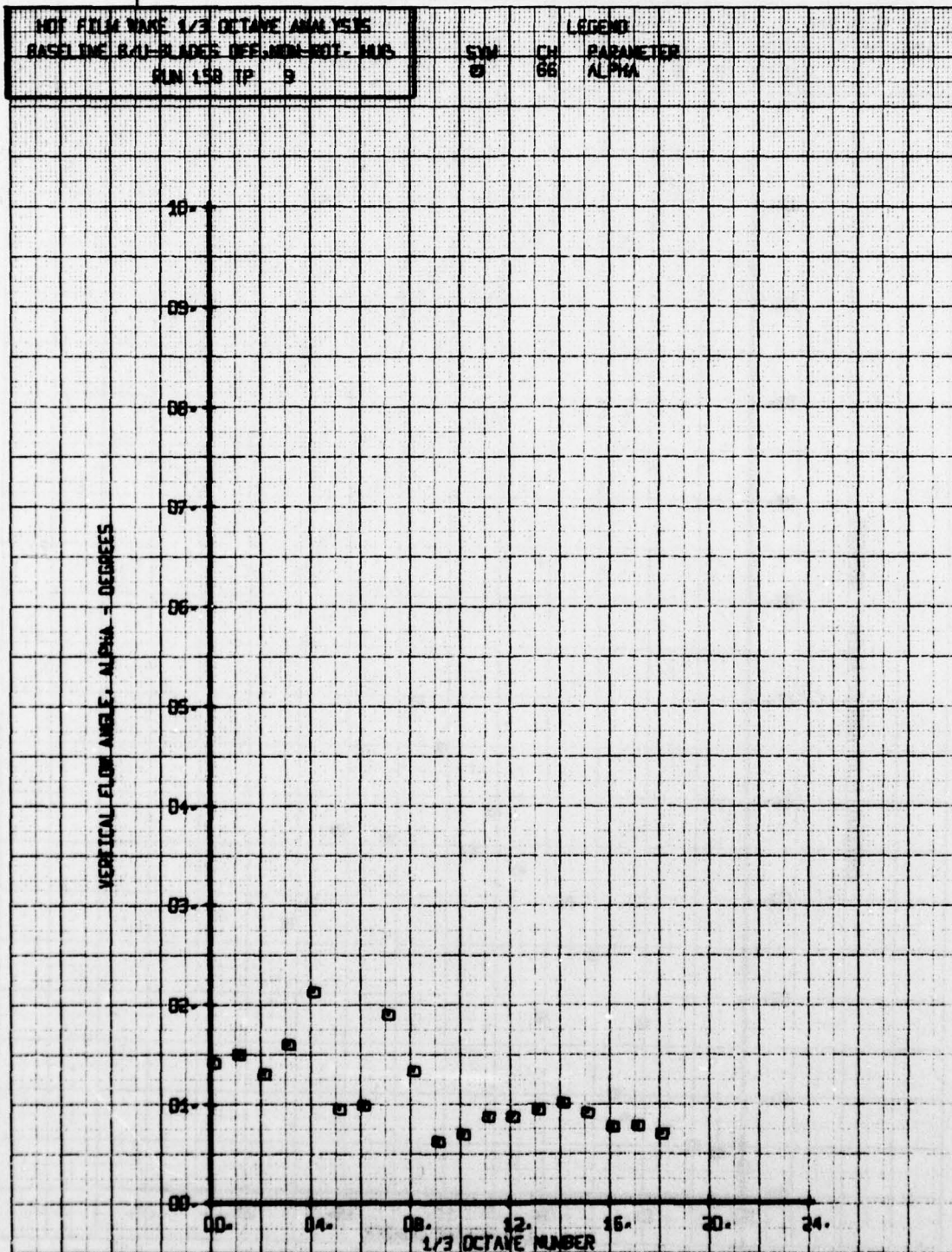




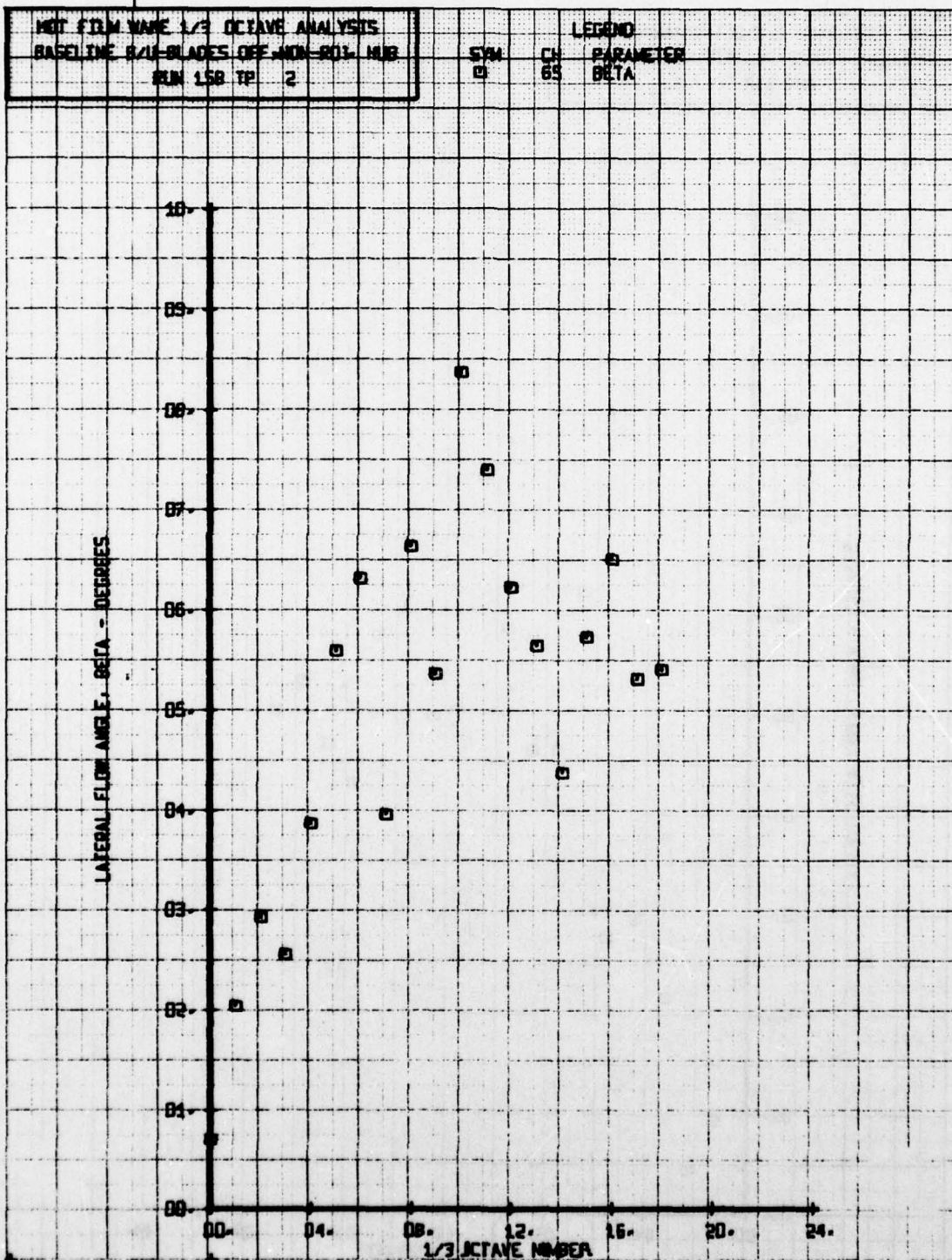
HOT FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE B/U-BLADGES OFF-NON-ROT. MUR  
 RUN 152 TP 8

LEGEND  
 CH 66  
 PARAMETER  
 ALPHA



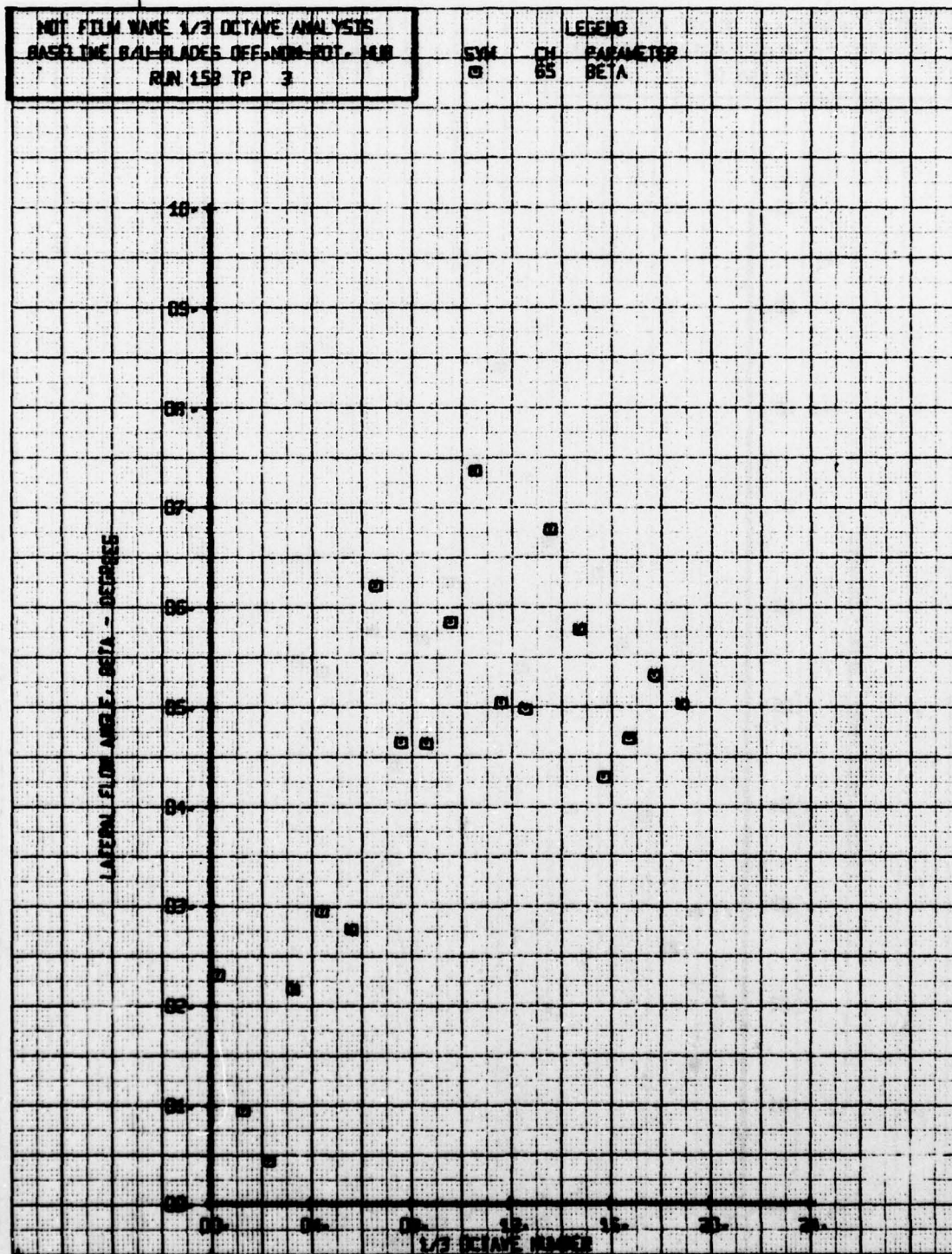






NOT FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE BALL BLADES OFF-NOM-ROT. MIN  
 RUN 152 TP 3

SYM	CH	PARAMETER
Q	65	BETA





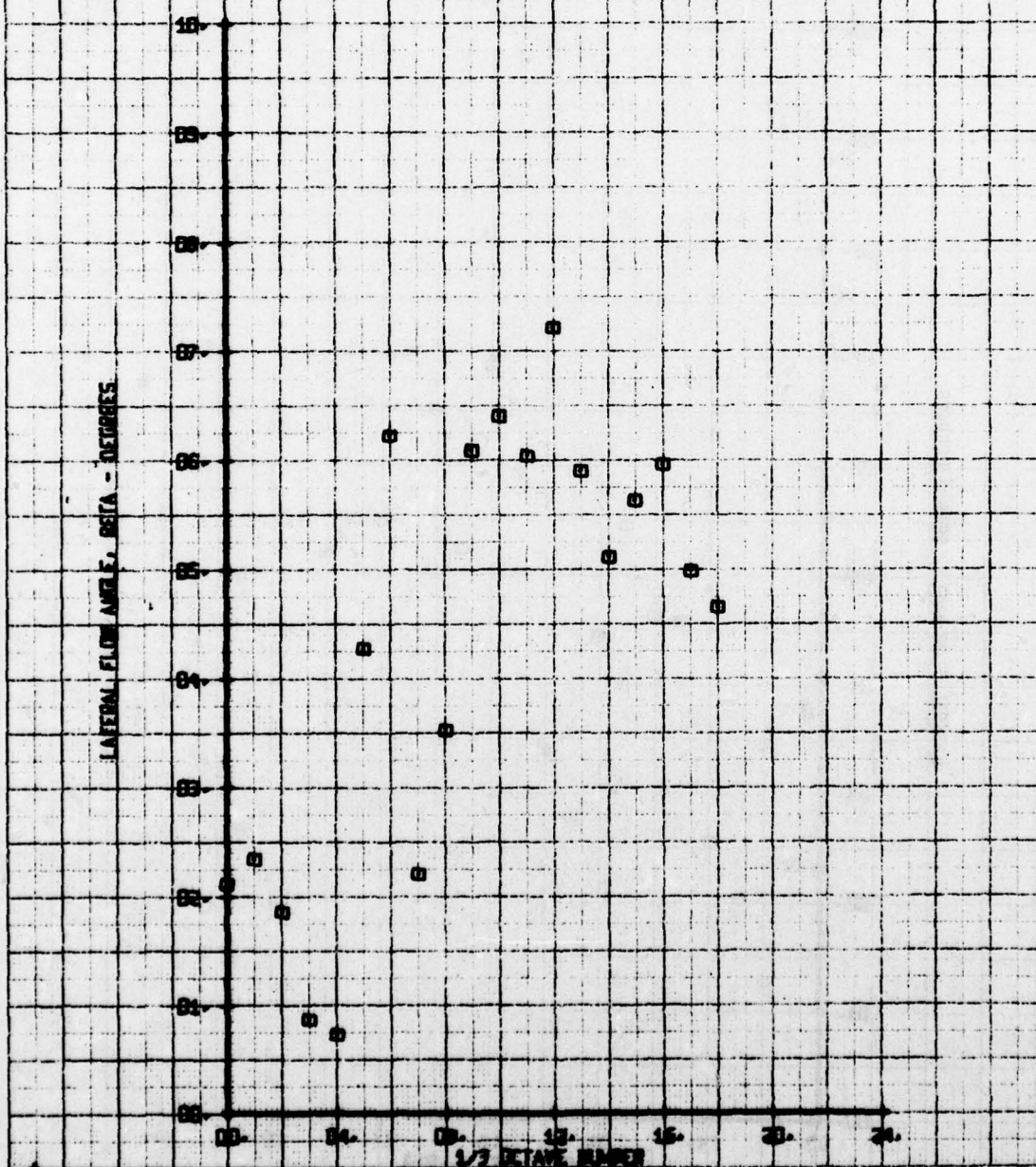
HIR FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE 8/11 BLADES OFF-MON-ROT. HIR  
 RUN 158 TP 4

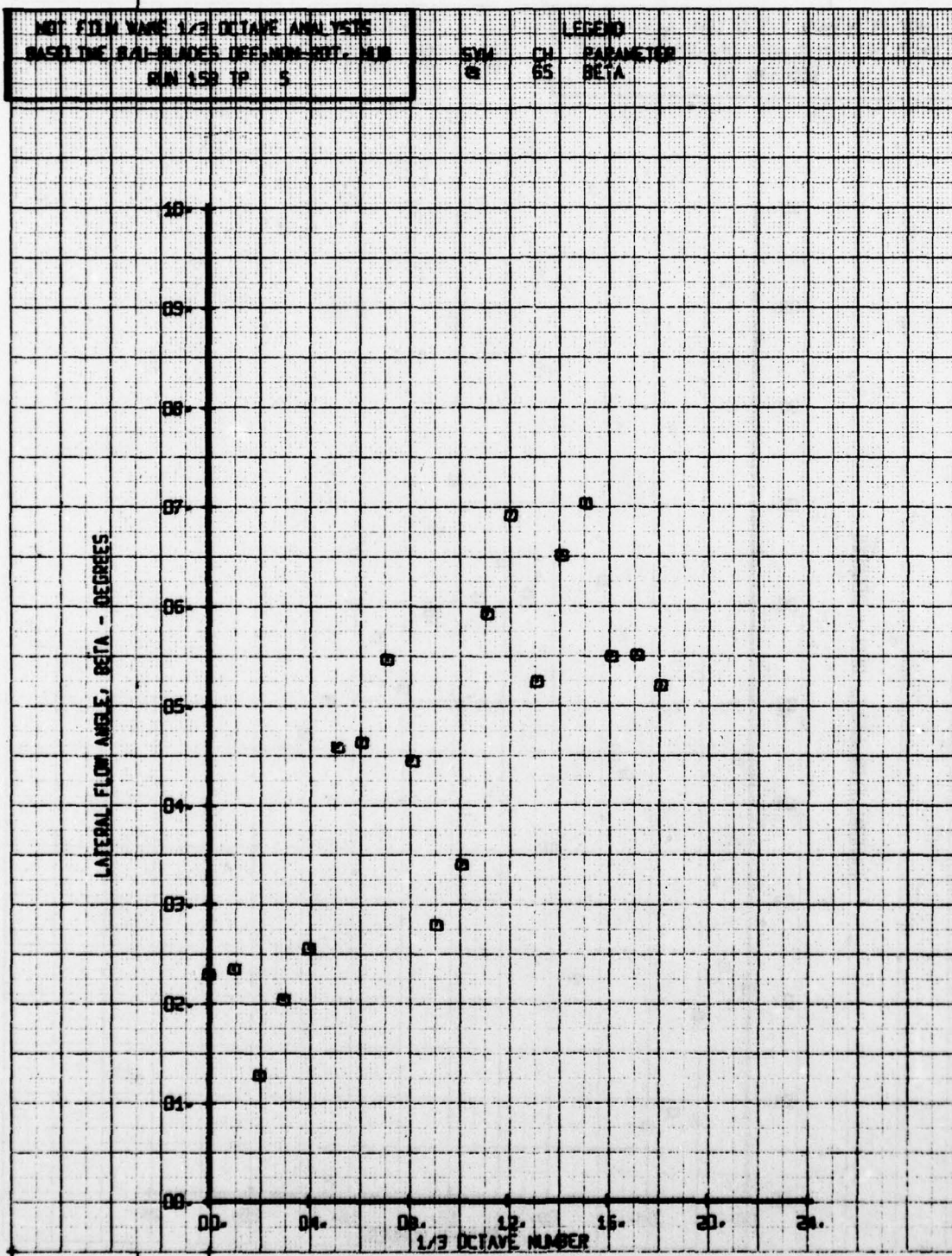
SYM  
 □

CH  
 65

LEGEND  
 PARAMETER  
 BETA

LATERAL FLOW ANGLE, BETA - DEGREES



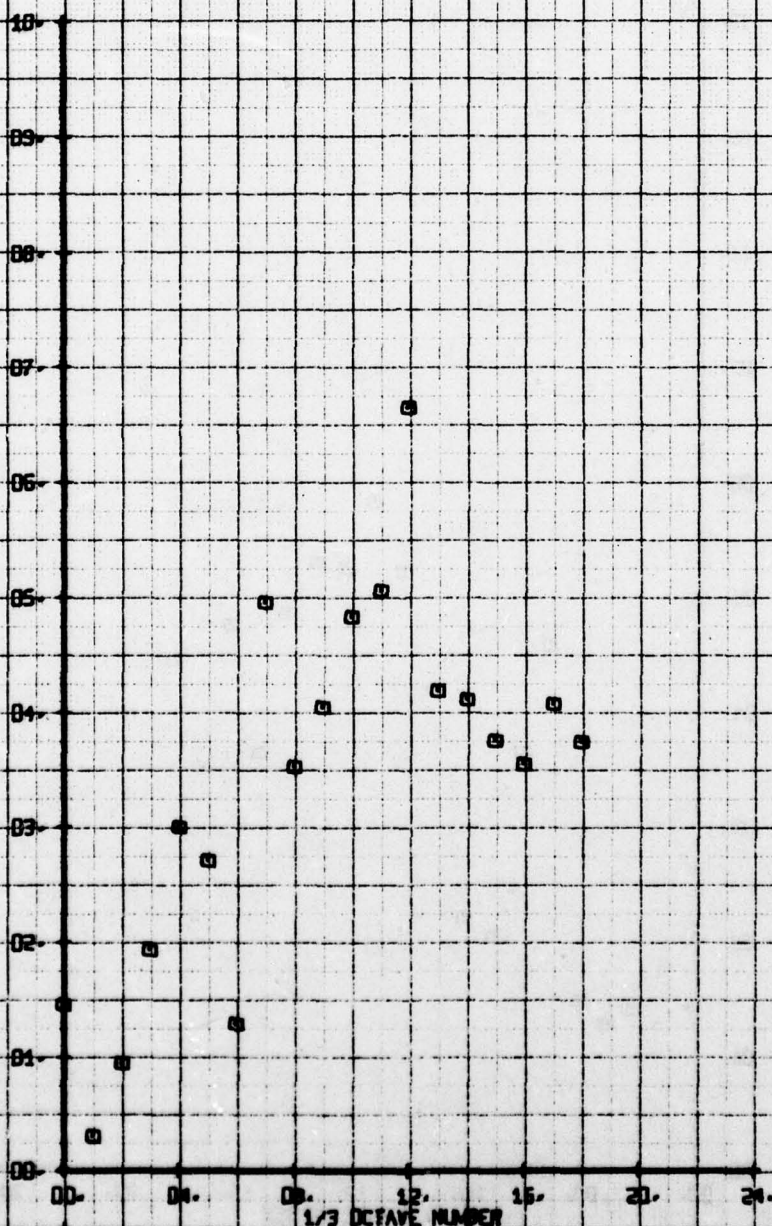




NOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE BAIL-BLADES OFF-NOM-ROT. MIN  
 RUN 158 TP 6

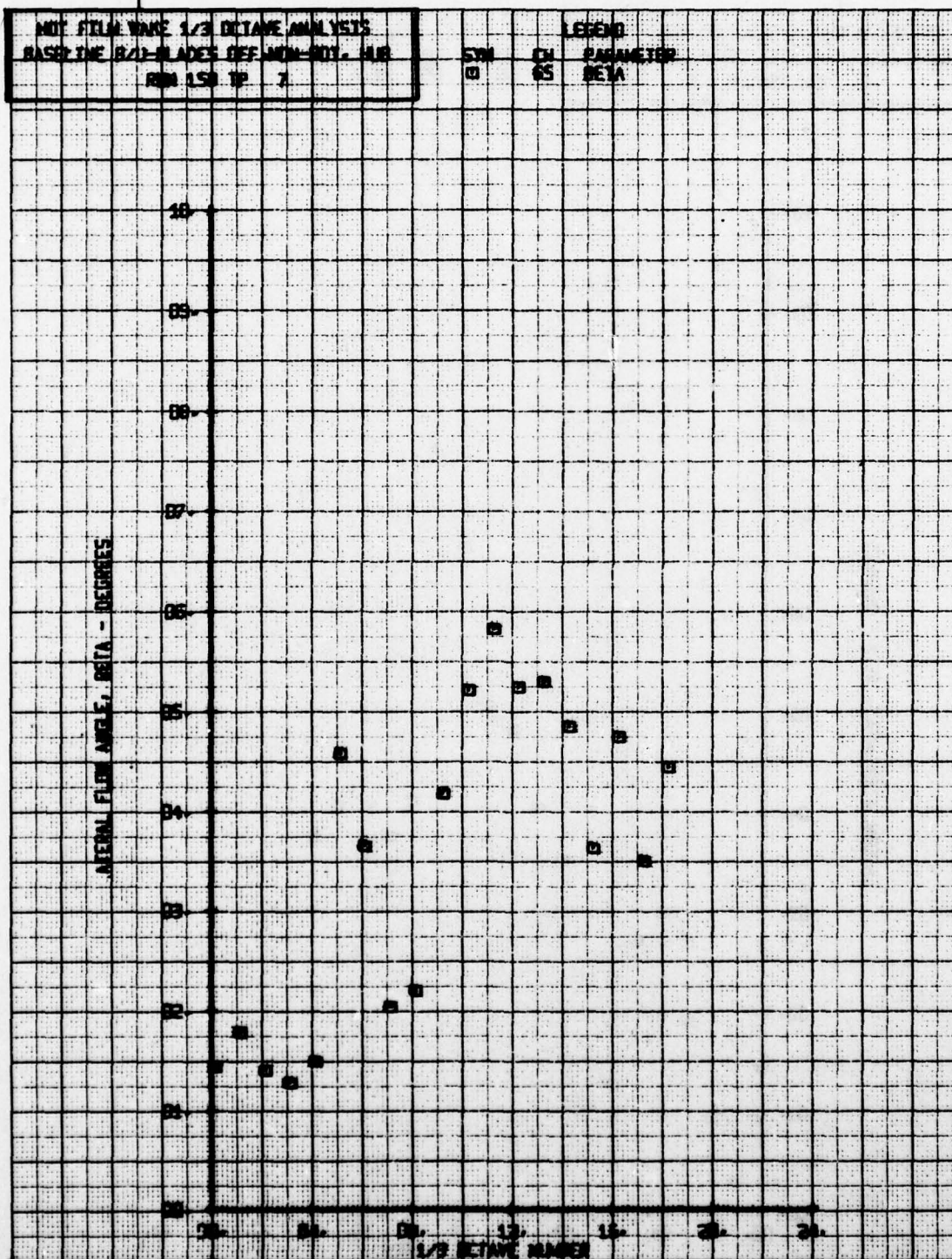
SYM CH PARAMETER  
 0 65 BETA

LATERAL FLOW ANGLE, BETA - DEGREES



MIT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASED ON 8/12 BLADES OFF MAIN ROT. HUB  
 RUN 150 TP 7

SYN CH PARAMETER  
 0 05 BETA



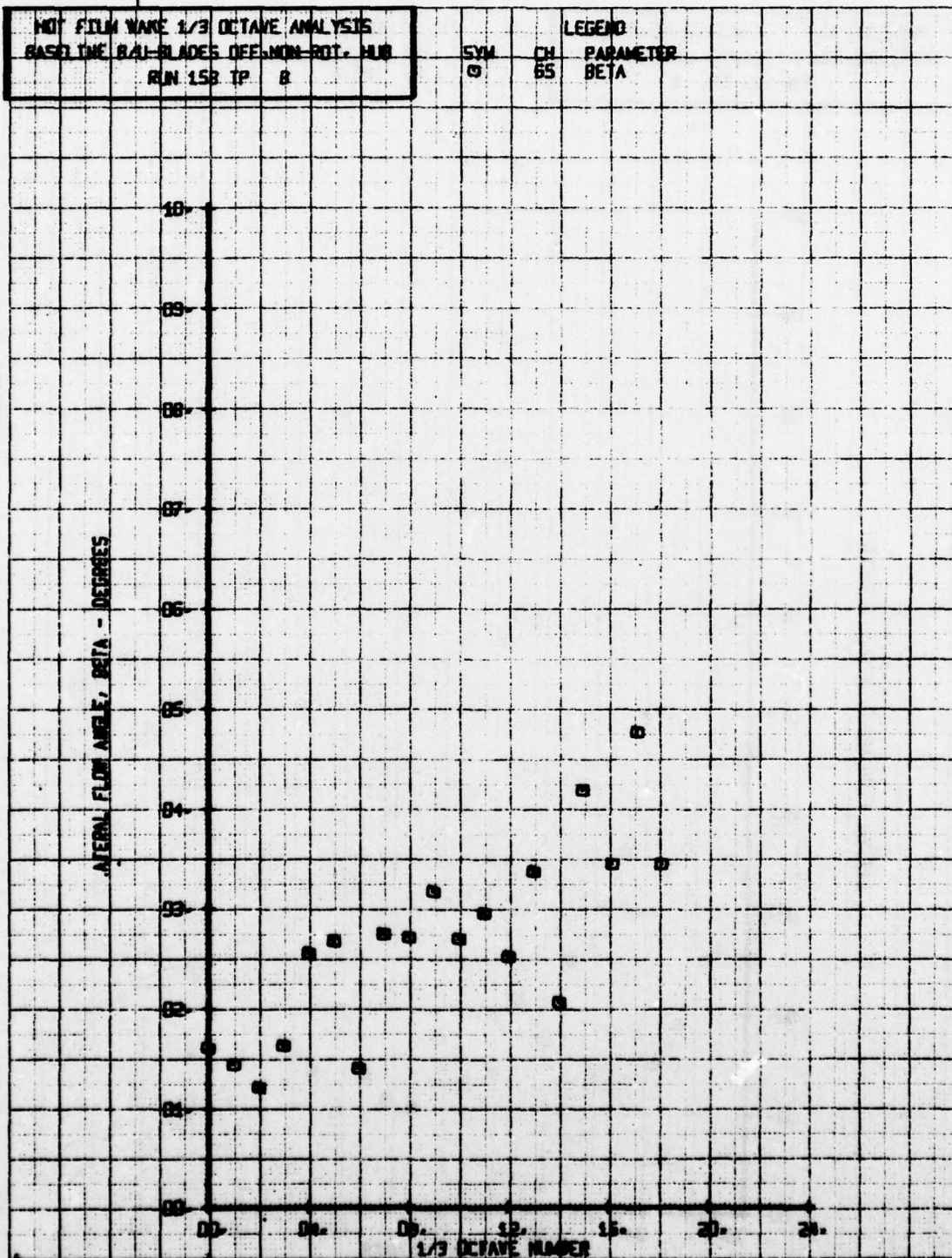


HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE RAIL-BLADES OFF-NON-ROT. HUB  
 RUN 158 TP 8

SYM  
 0

CH  
 65

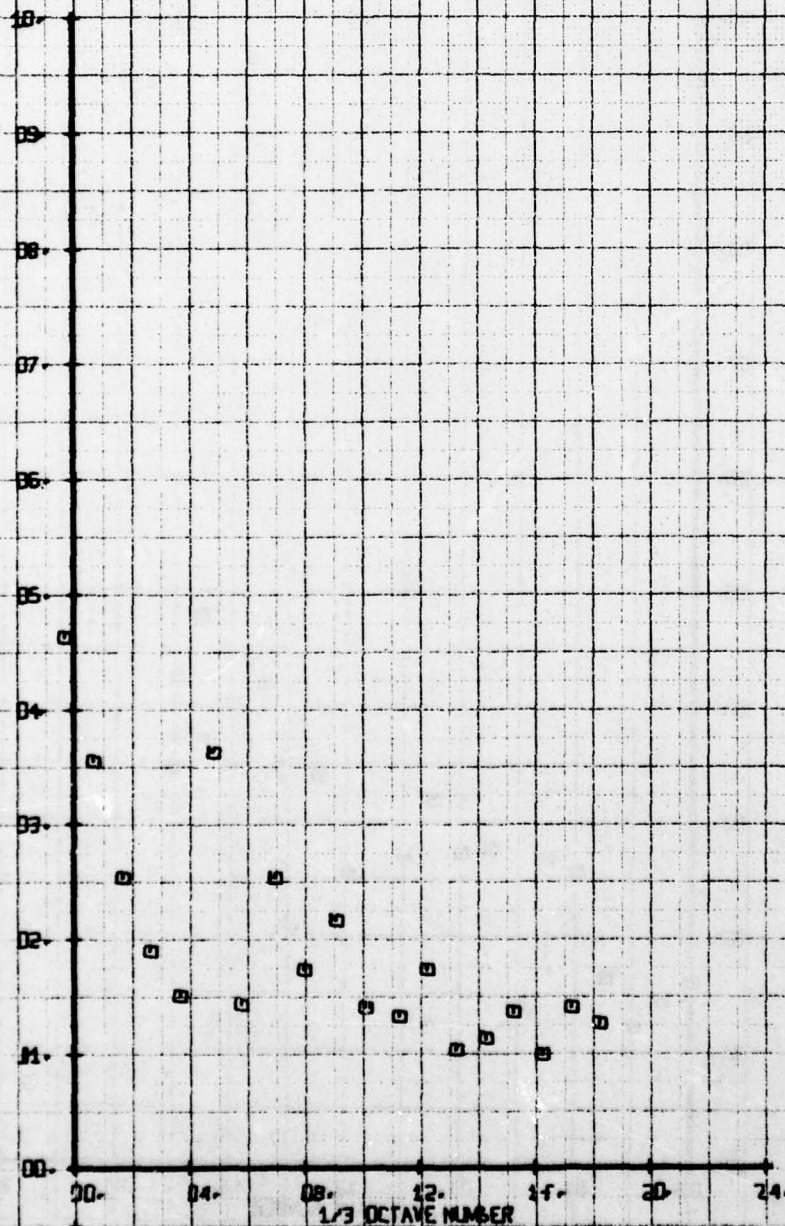
LEGEND  
 PARAMETER  
 BETA



HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE 8/1-BLADES OFF-NON-ROT. HUB  
 RUN 158 JP 3

LEGEND	
SYM	CH
□	65
	PARAMETER
	BETA

LATERAL FLOW ANGLE, BETA - DEGREES

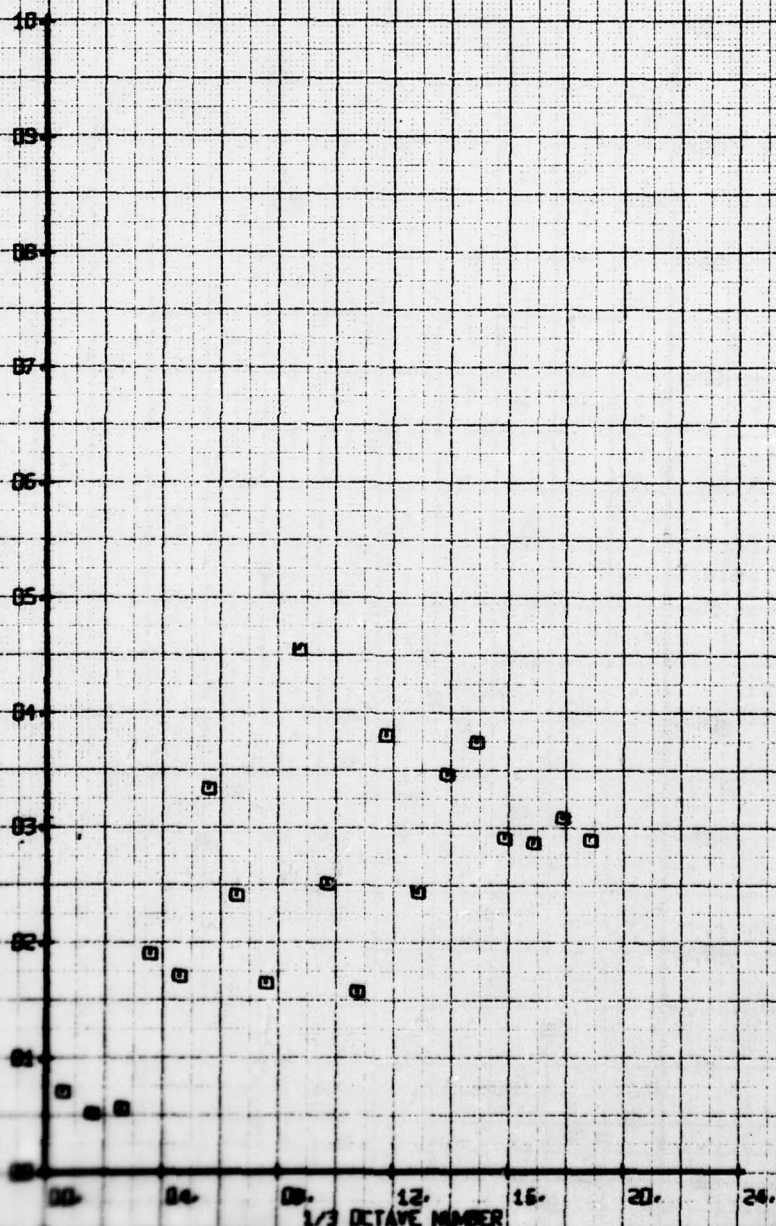




MOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE B/U-BLADES OFF, NON-ROT. MUR  
 RUN 158 TP 2

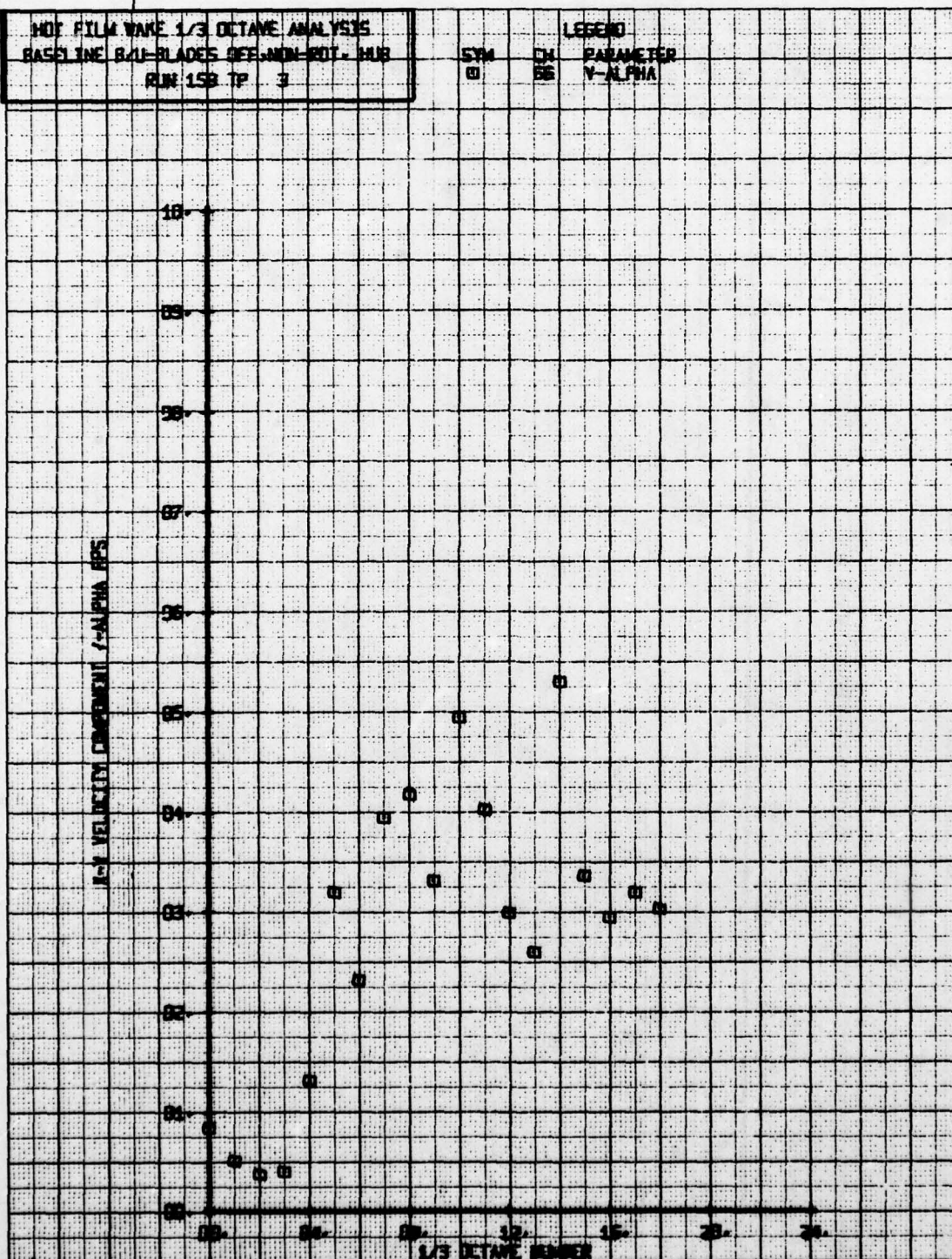
SYM CH PARAMETER  
 □ 65 Y-ALPHA

X-Y VELOCITY COMPONENT Y-ALPHA RPS

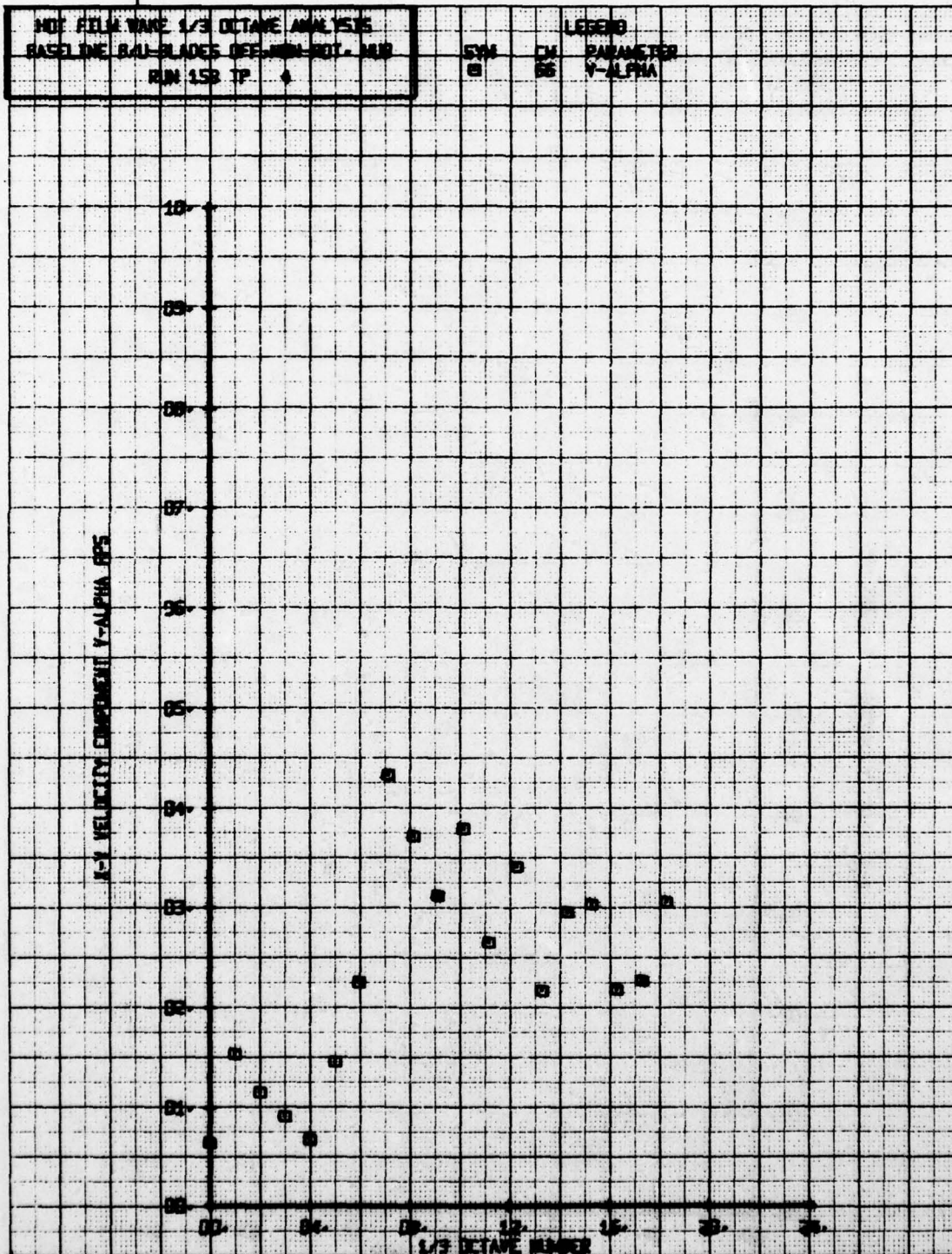


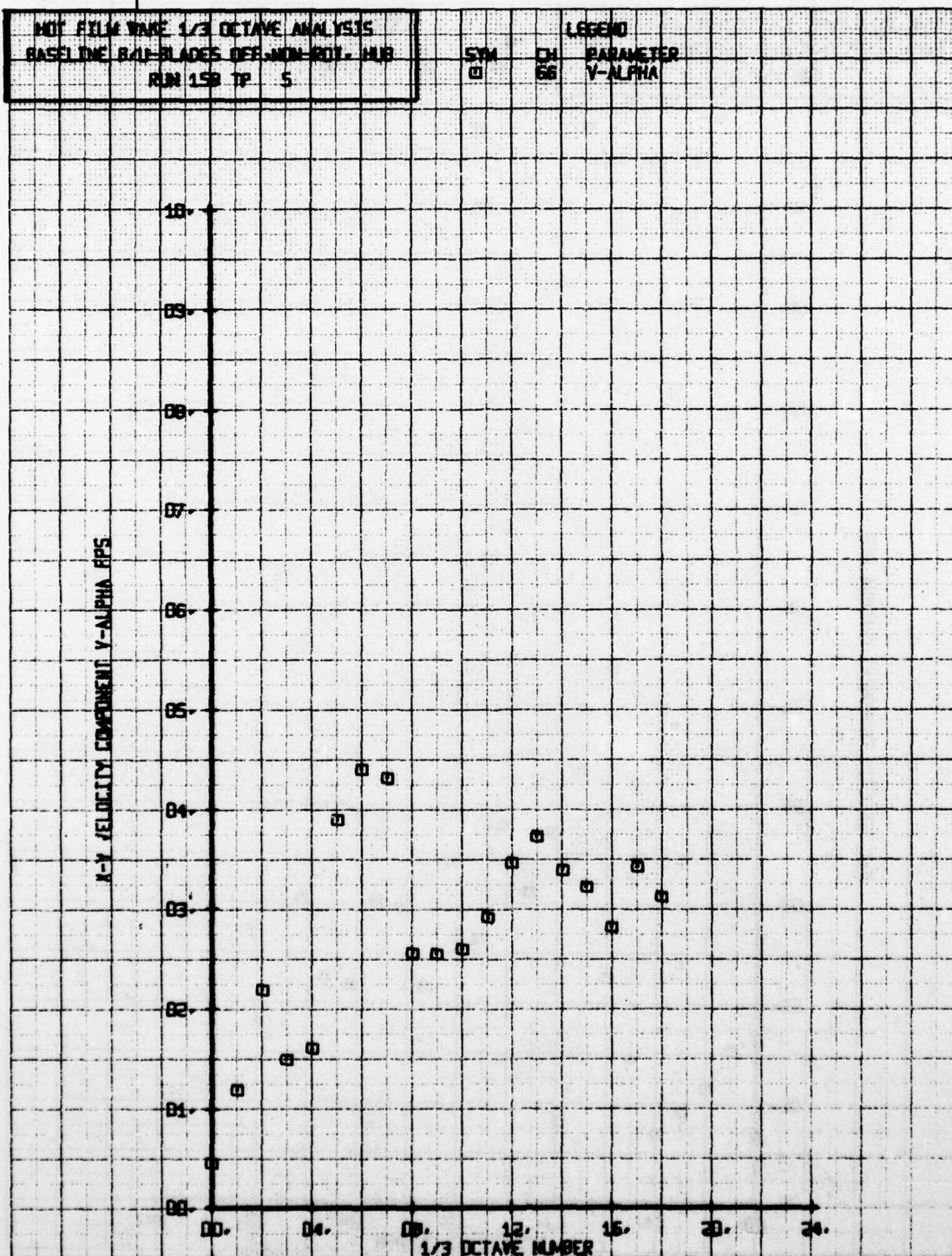
HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE B-11-BLADES OFF-NON-ROT. HUB  
 RUN 158 TP 3

SYM CH PARAMETER  
 0 55 Y-ALPHA







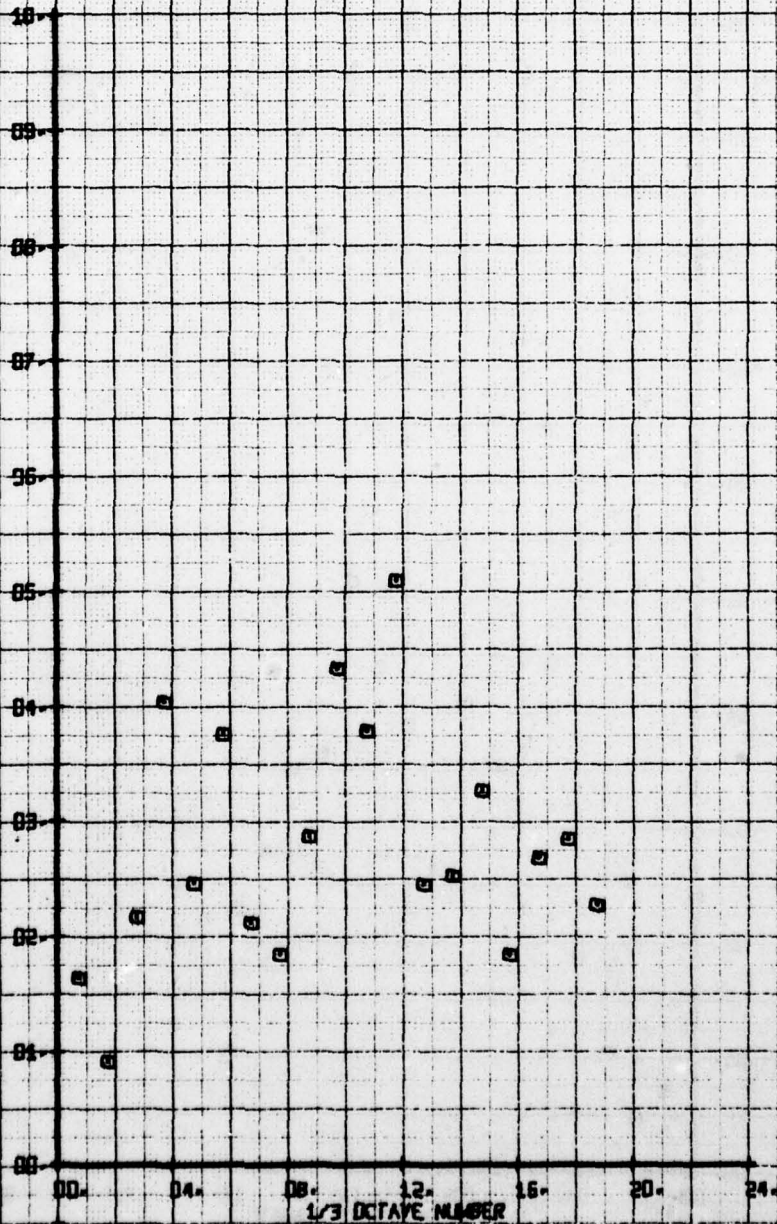


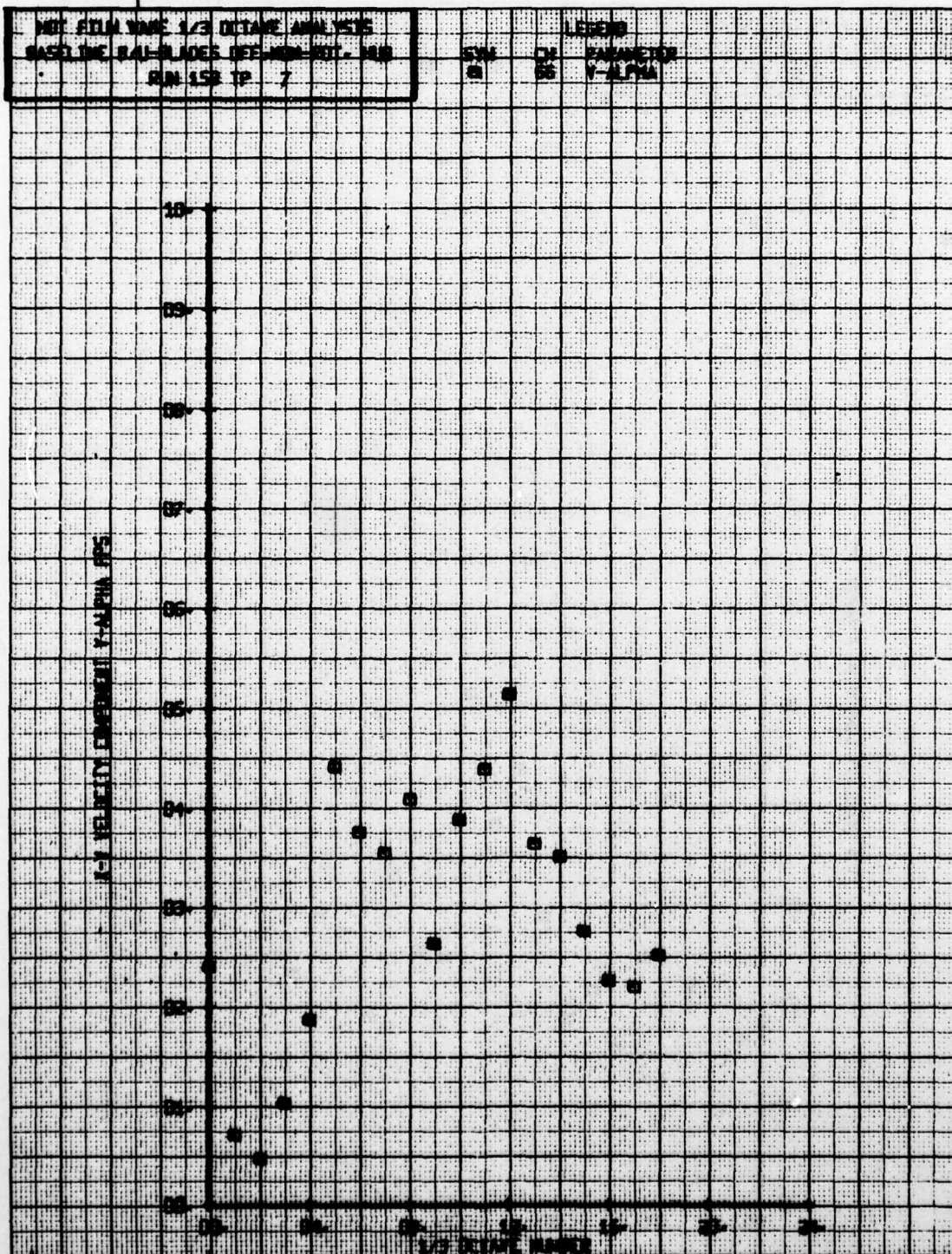


NOF FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE 8/4-8/10-5 OFF-NON-ROT. HUB  
 RUN 158 IP 6

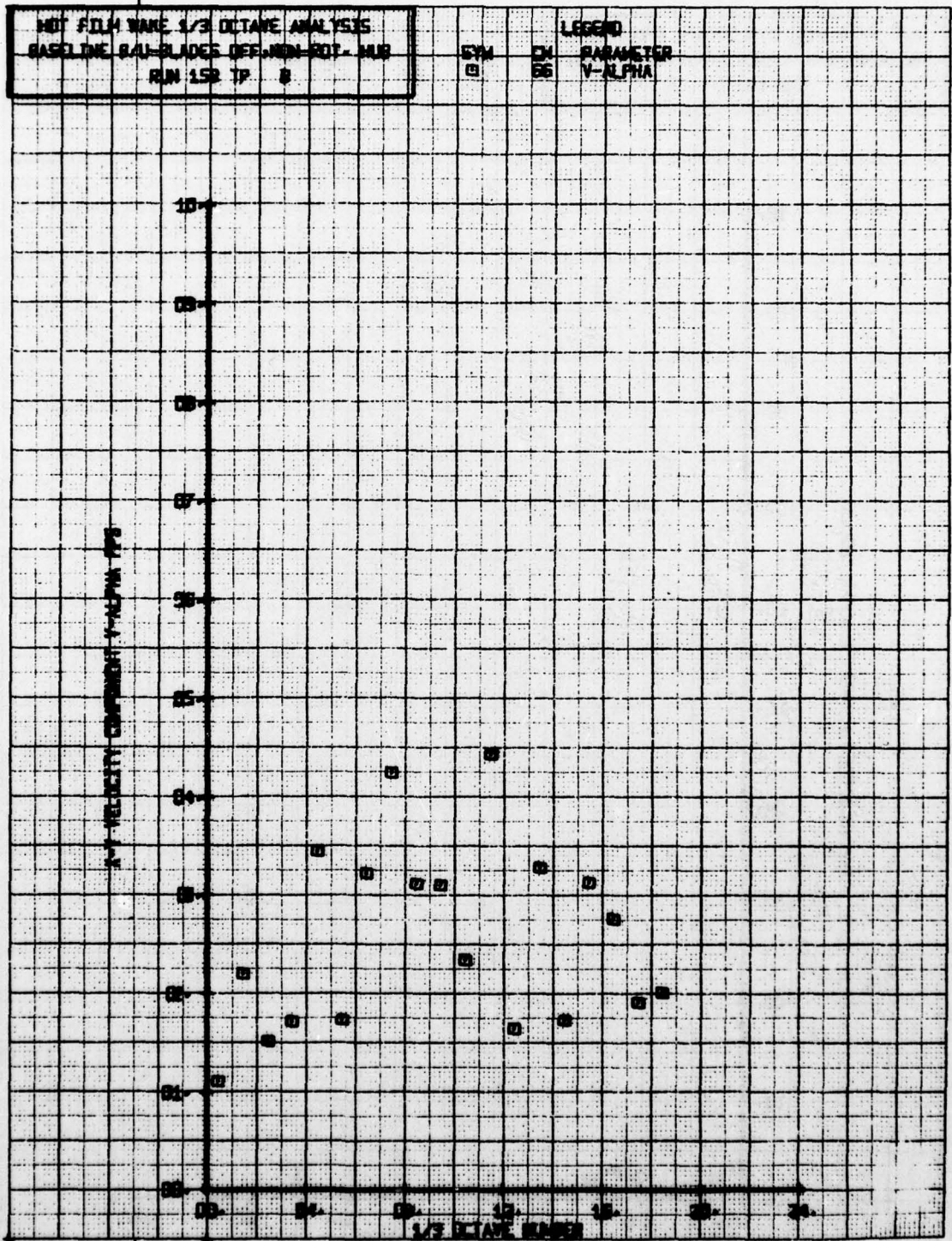
SYM CH PARAMETER  
 0 00 V-ALPHA

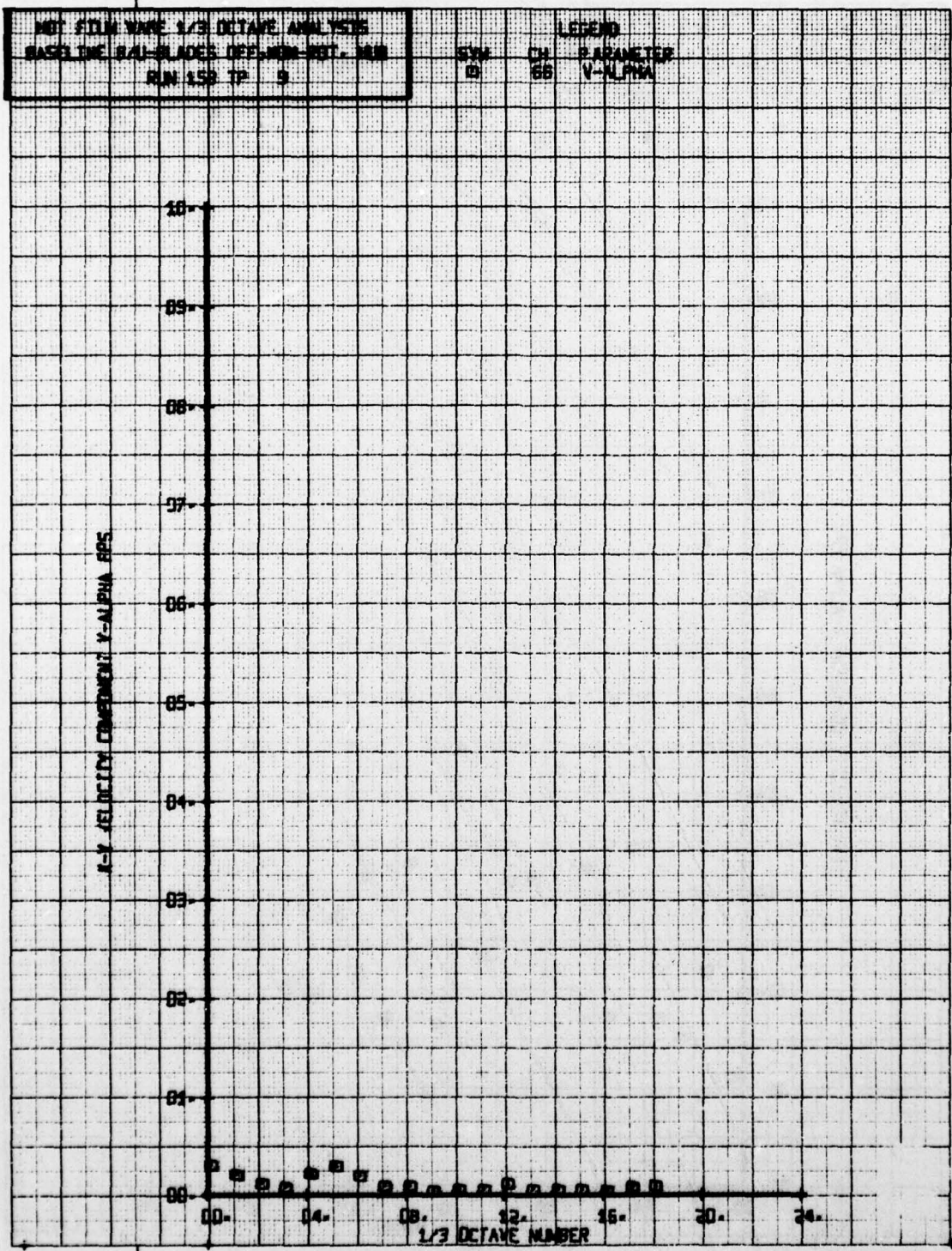
(-7) VELOCITY COMPONENT V-ALPHA RPS



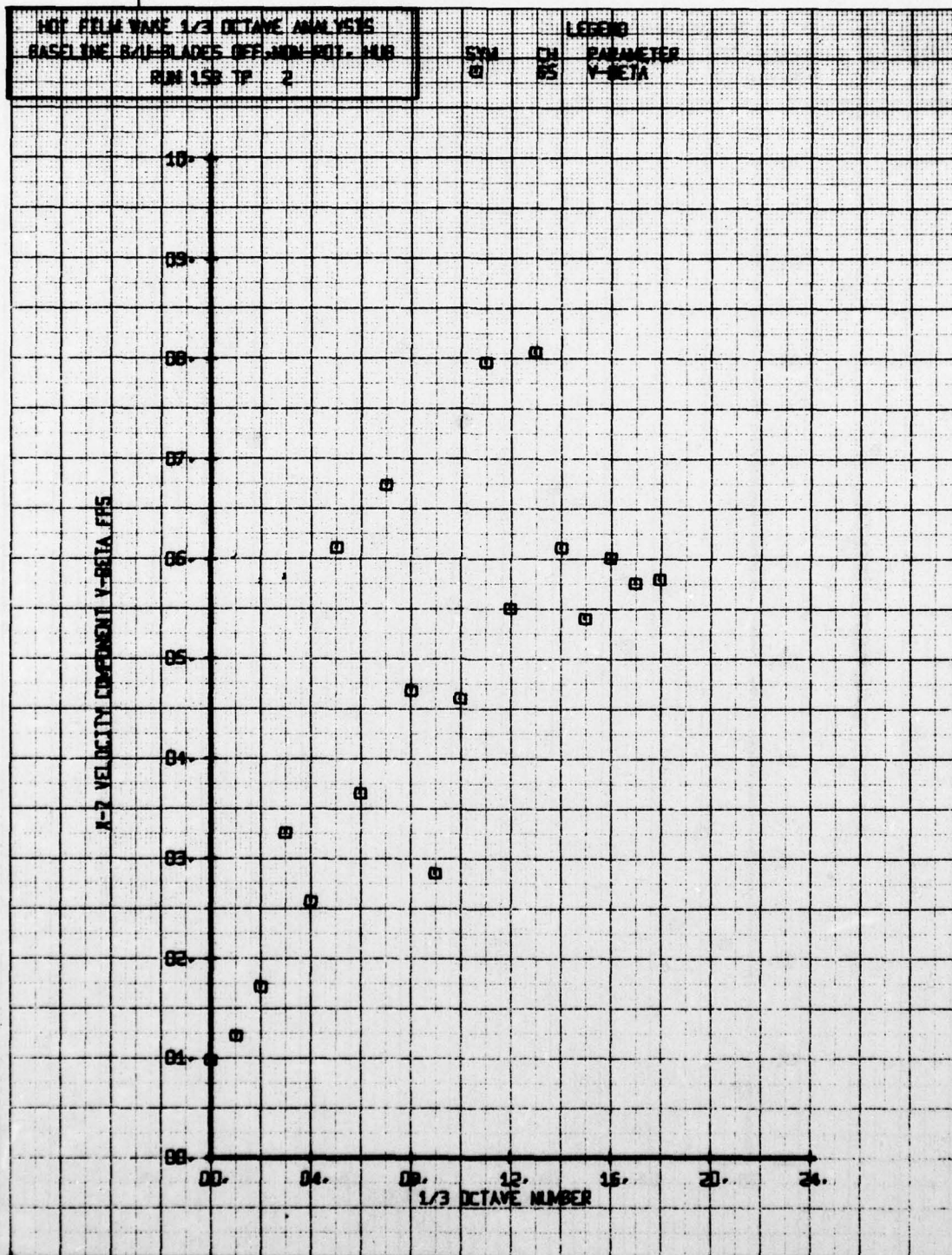


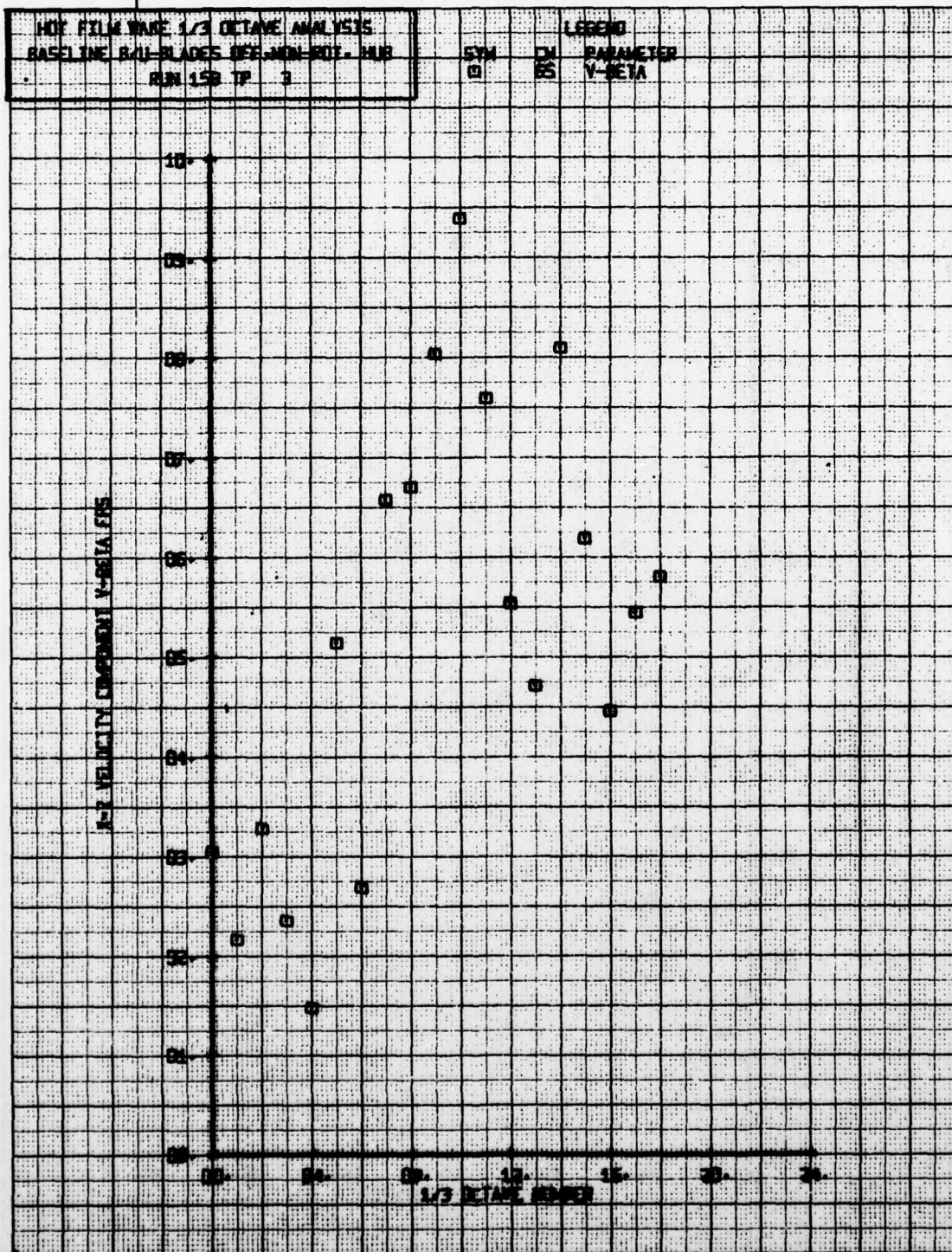




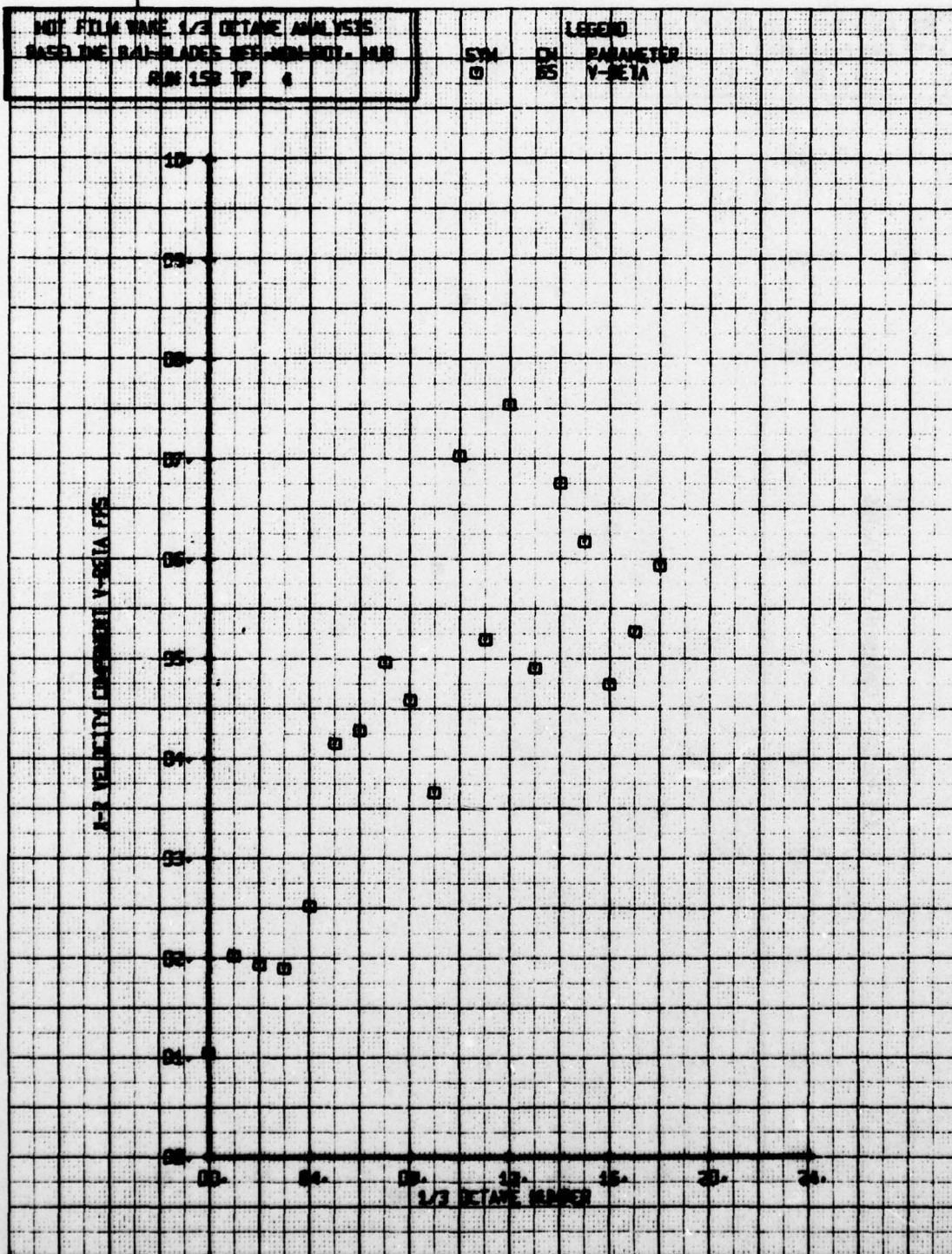


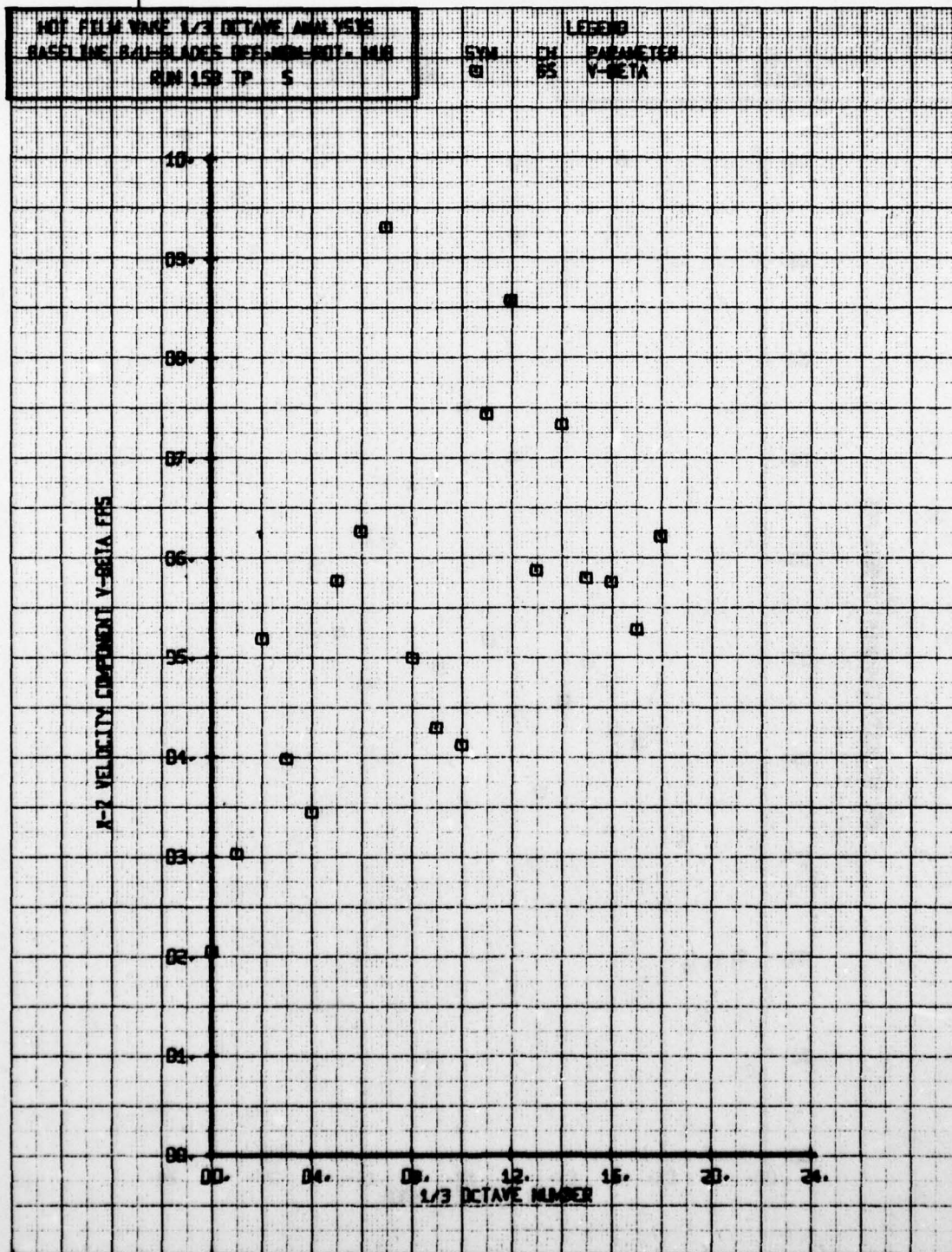




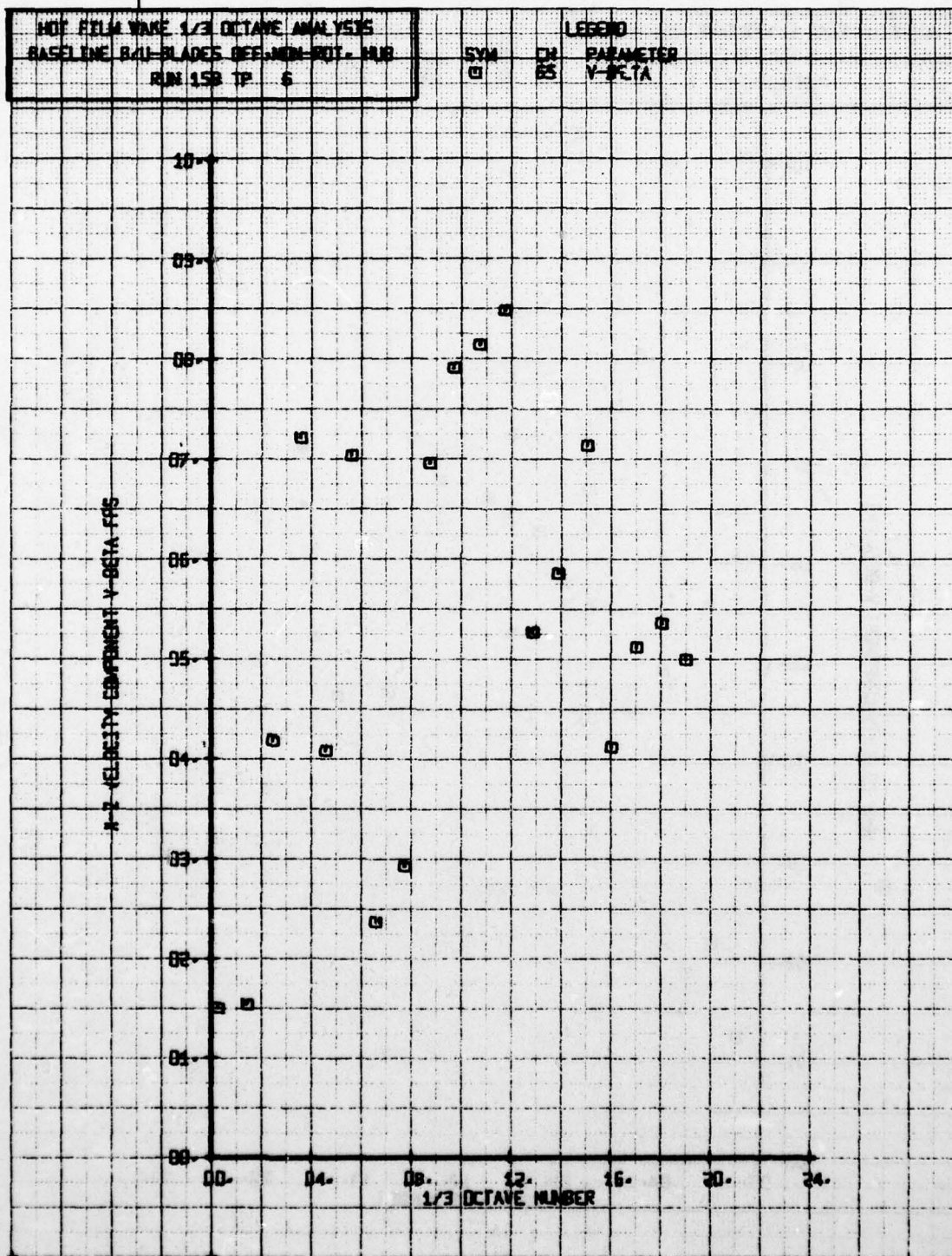


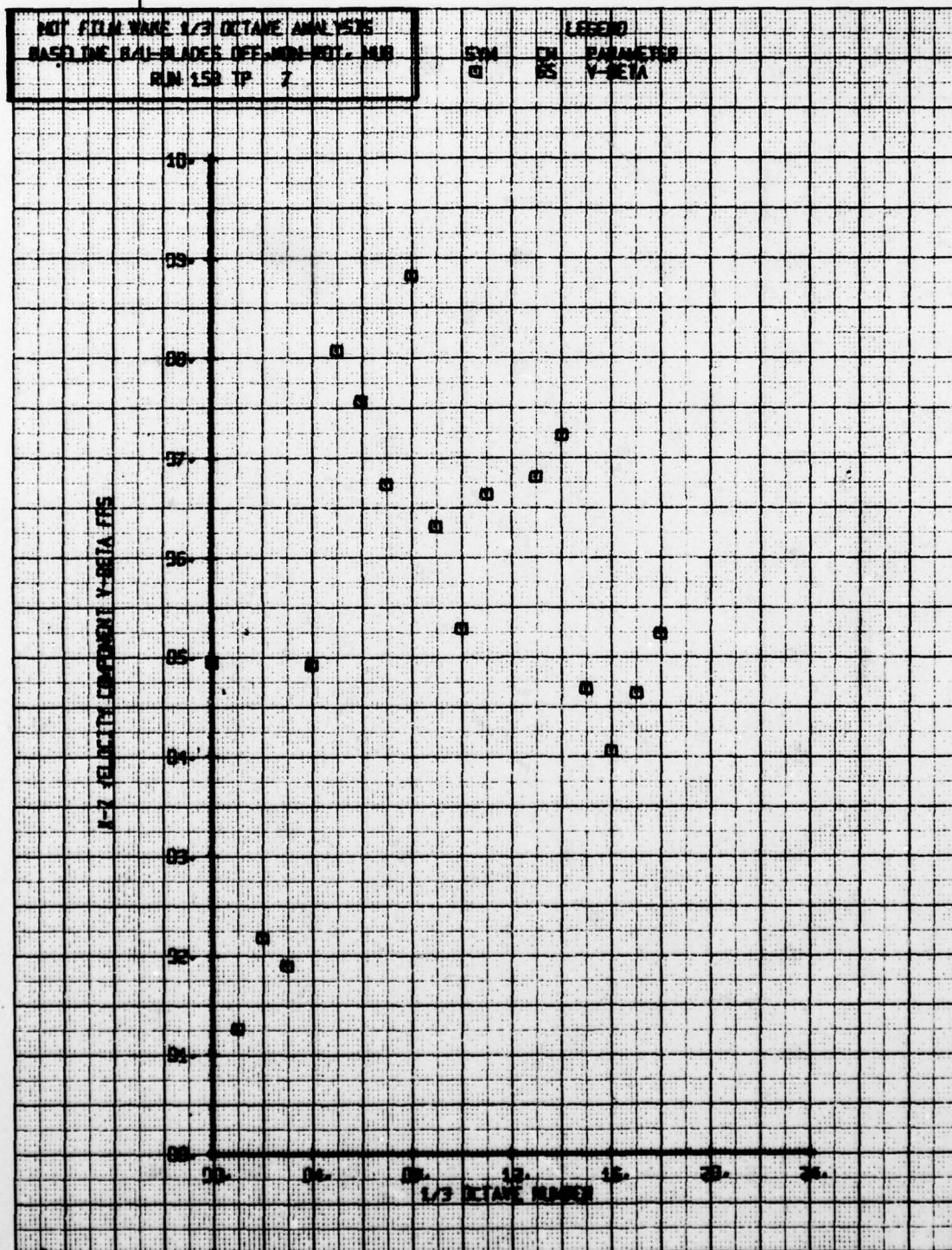














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BOEING VERTOL CO PHILADELPHIA PA

F/G 1/3

INTERACTIONAL AERODYNAMICS OF THE SINGLE ROTOR HELICOPTER CONF1--ETC(U)

SEP 78 P F SHERIDAN

DAAJ02-77-C-0020

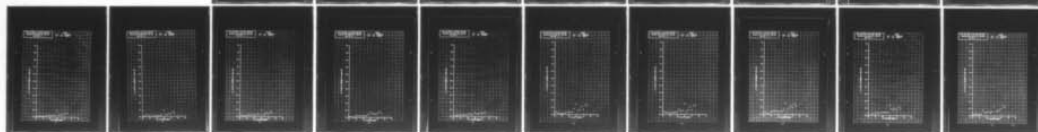
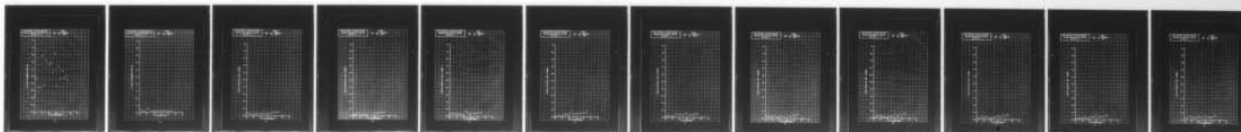
UNCLASSIFIED

USARTL-TR-78-230

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3 OF 3

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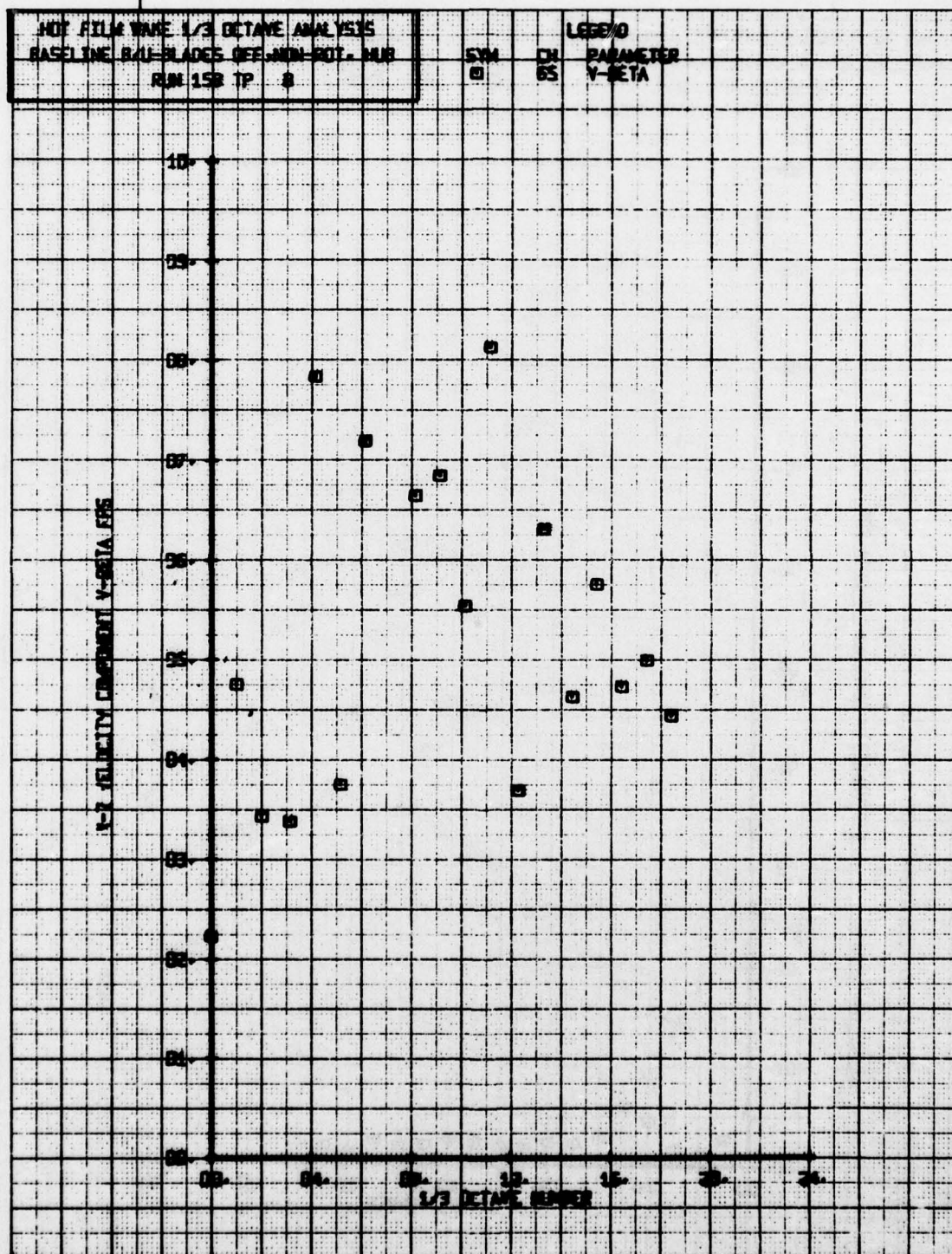


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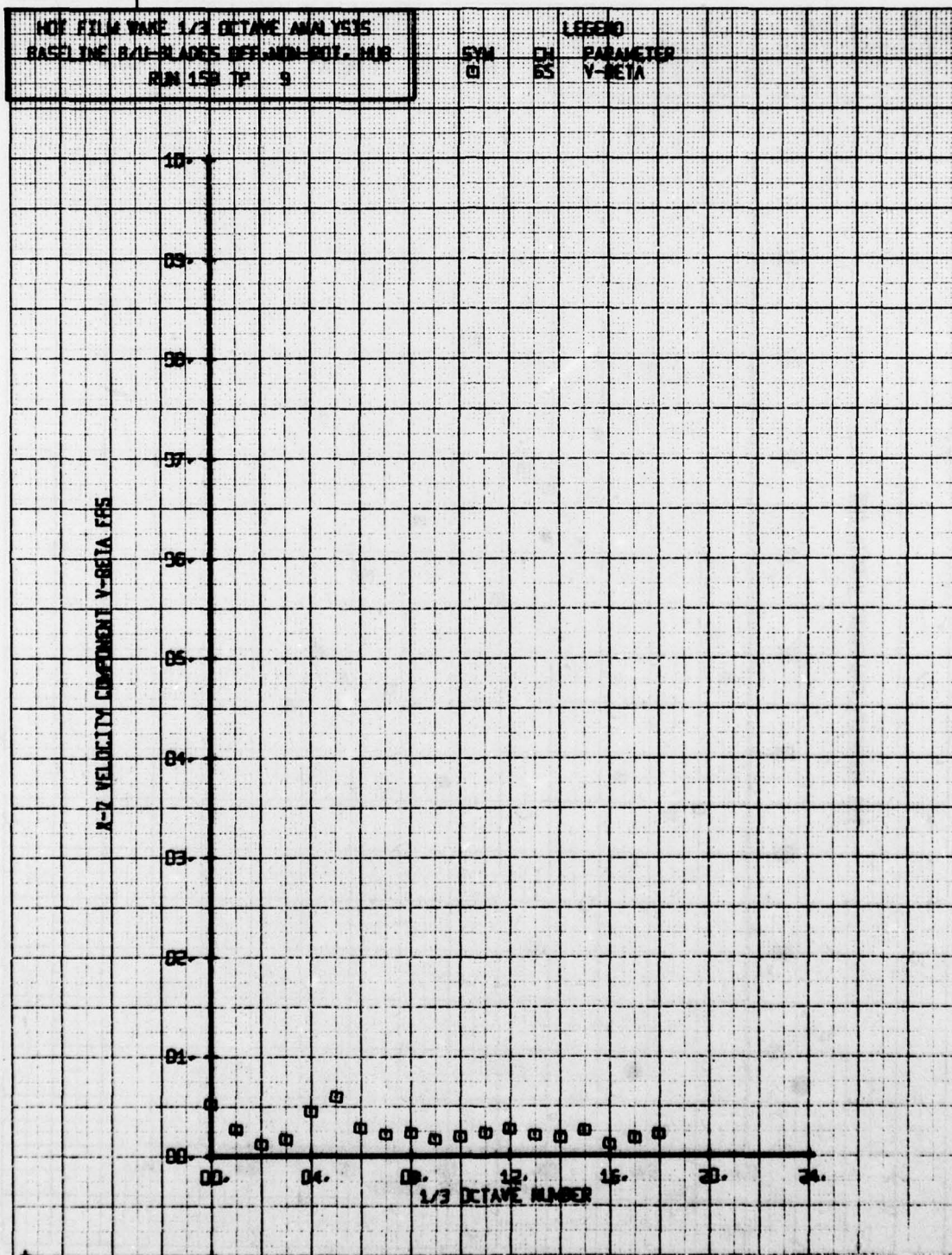
DATE  
FILMED

3-79

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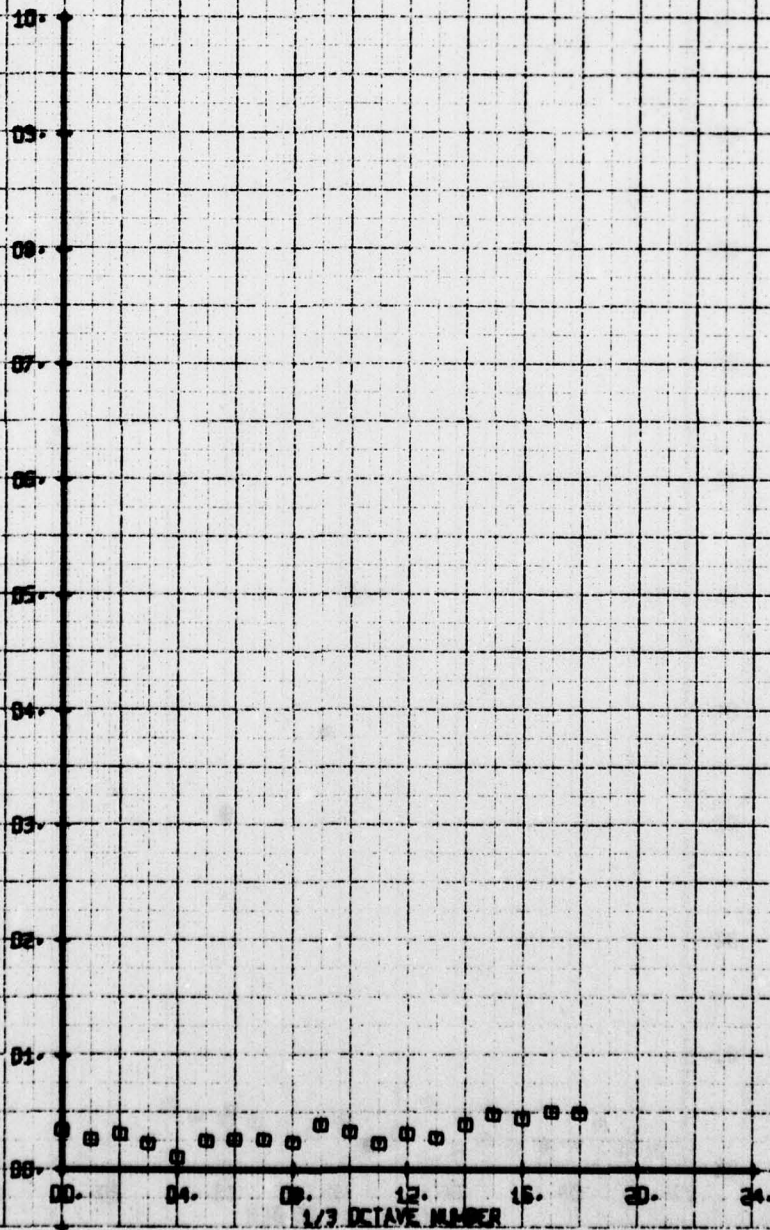
HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE 8-1-1 BLADES OFF, HUB OFF  
 RUN 150 TP 1

SYM  
 0

CH  
 66

LEGEND  
 PARAMETER  
 ALPHA

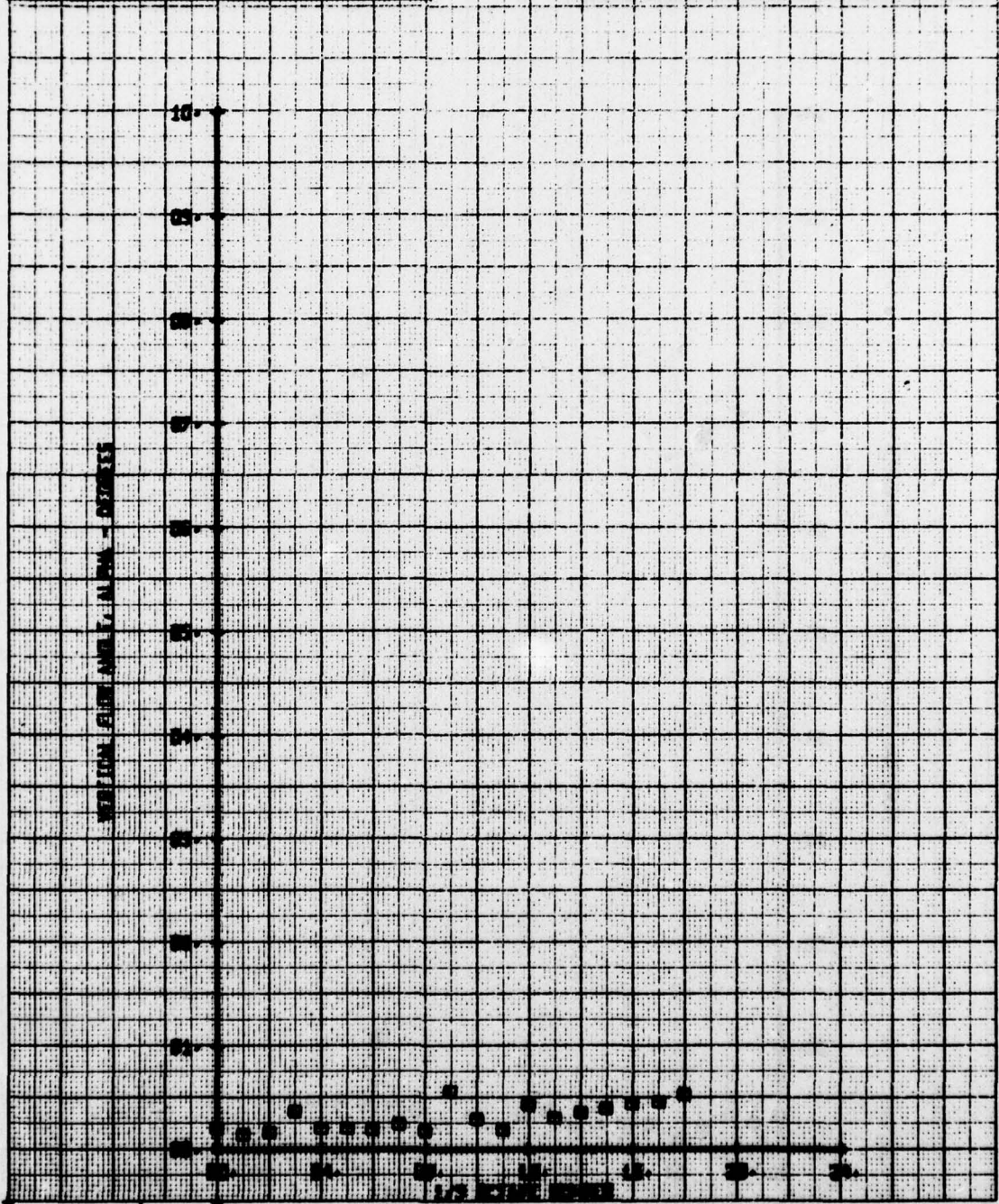
VERTICAL FLOW ANGLE, ALPHA - DEGREES



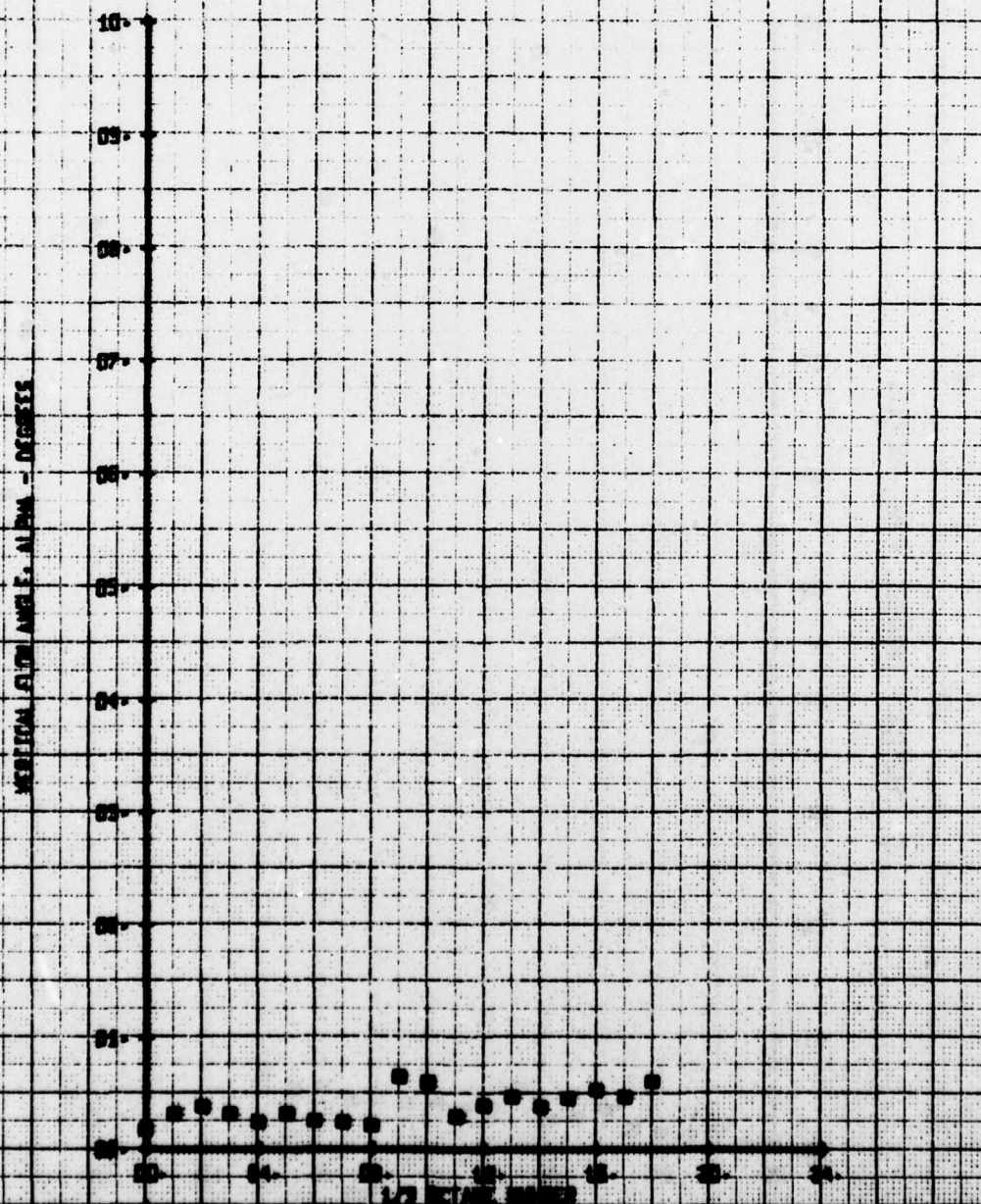


HOT FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE 840- BLADES OFF, HUB OFF  
 RUN 159 TP 2

SYM	CH	LEGEND
Q	66	PARAMETER
		ALPHA



LEGEND  
PARAMETER  
ALPHA

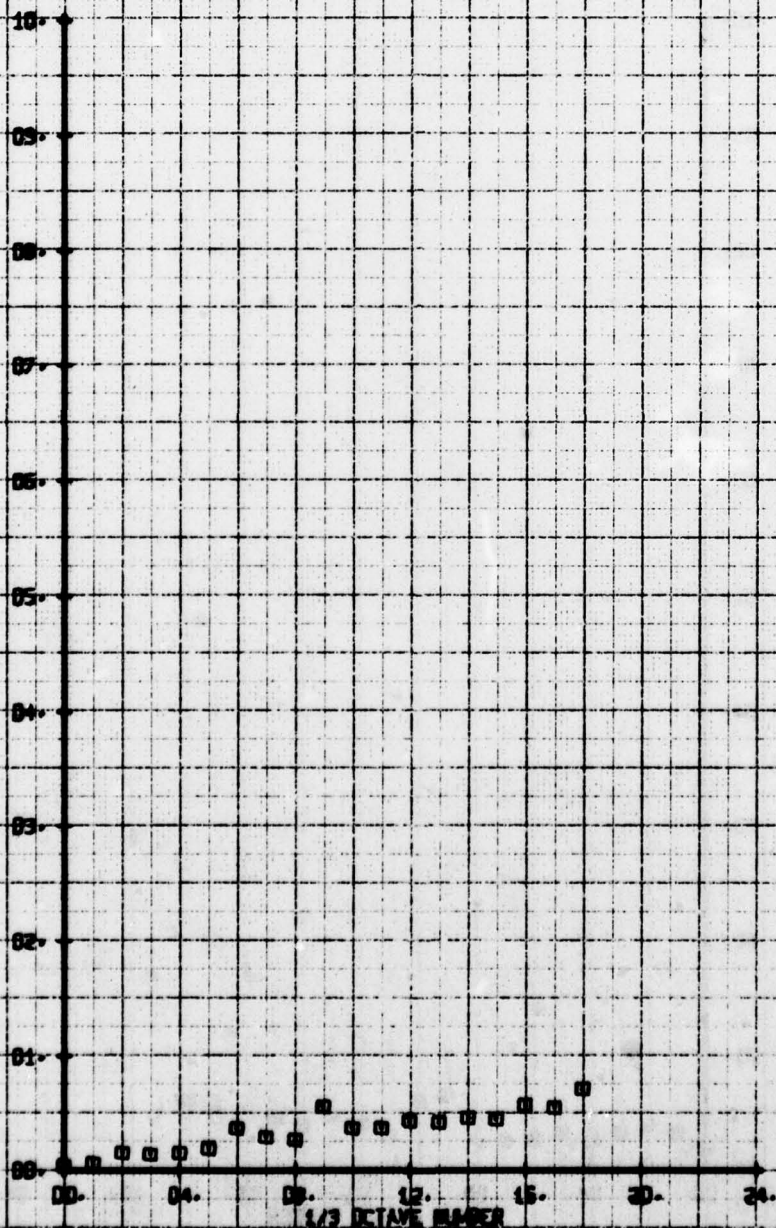




HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE 843-PLATES OFF, HUB OFF  
 RUN 150 TP 4

SYM	EN	LEGEND	PARAMETER
□	66		ALPHA

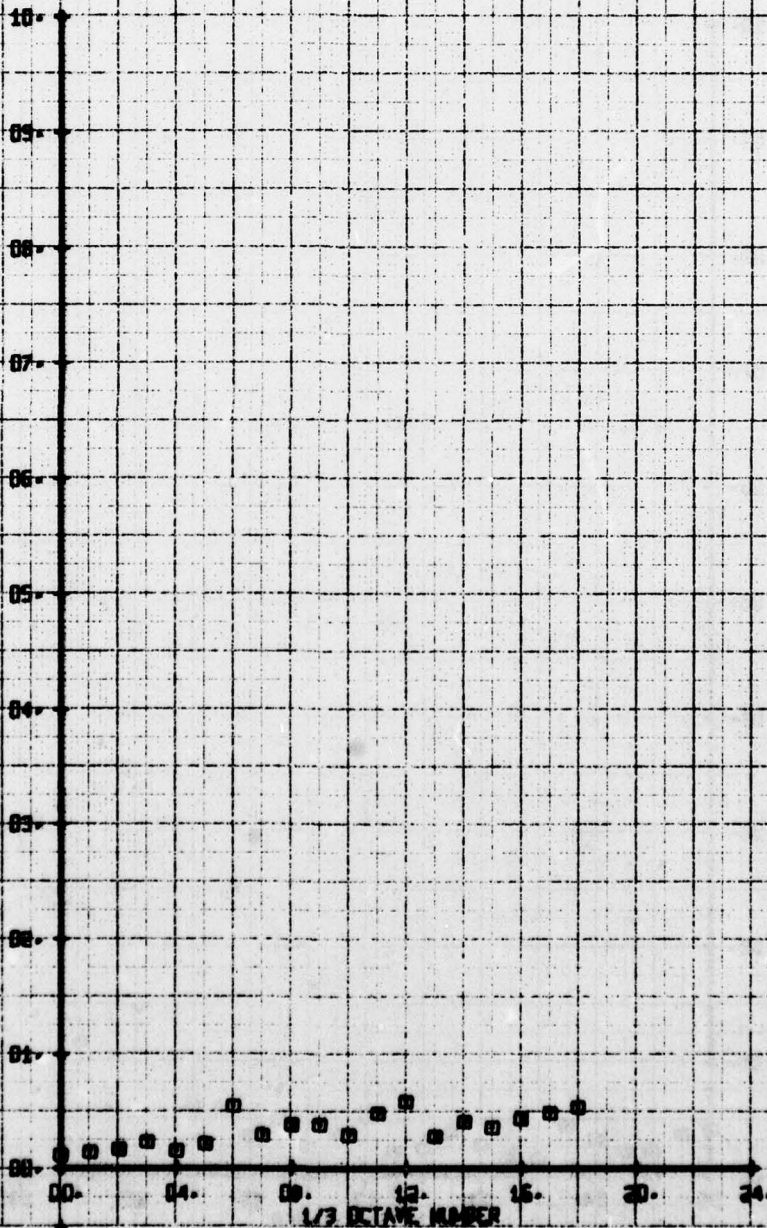
VERTICAL FLOW ANGLE, ALPHA - DEGREES



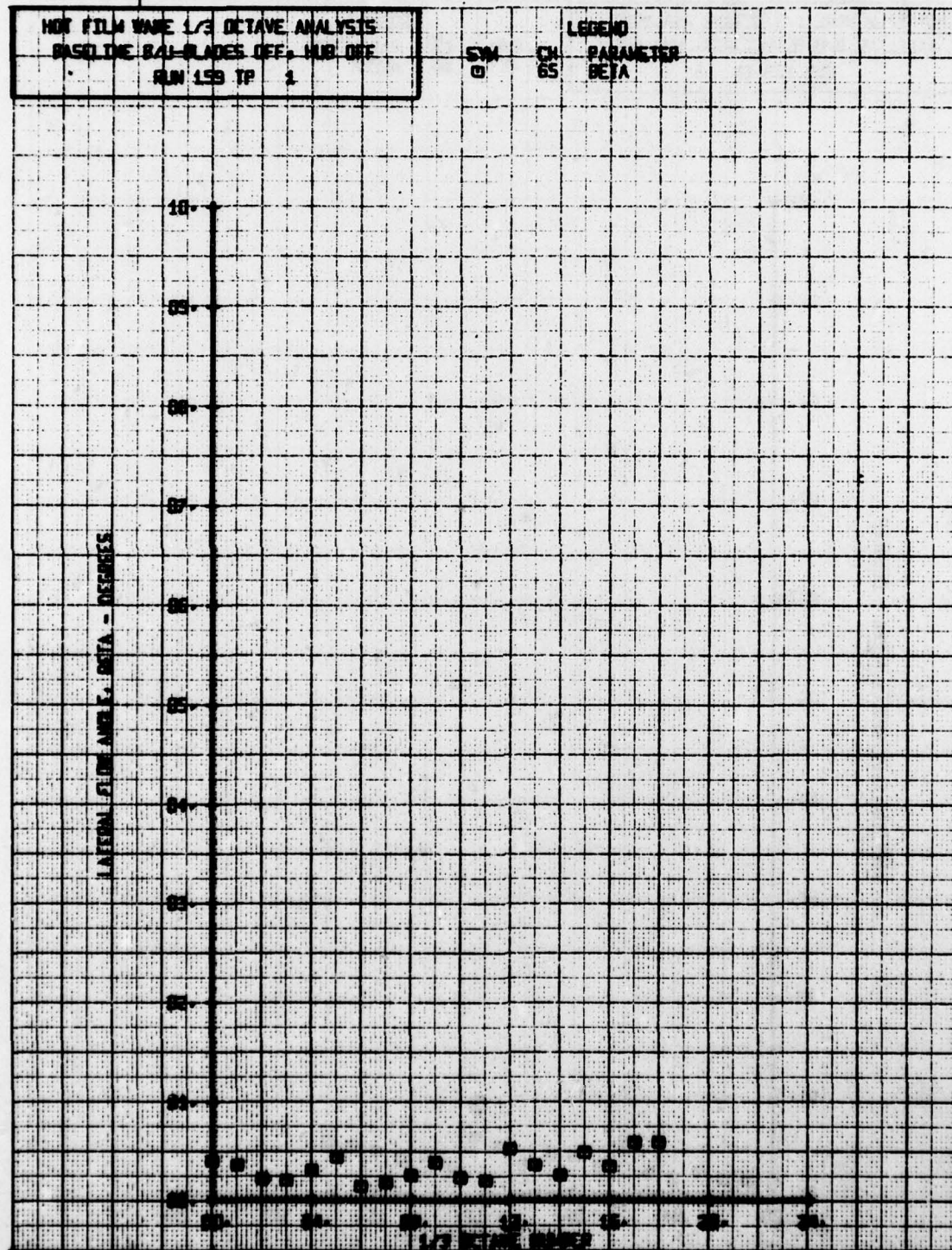
HOT FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE 84- BLADES OFF, HUB OFF  
 RUN 159 TP 5

SYM	CH	PARAMETER
0	66	ALPHA

VERTICAL FLOW ANGLE, ALPHA - DEGREES







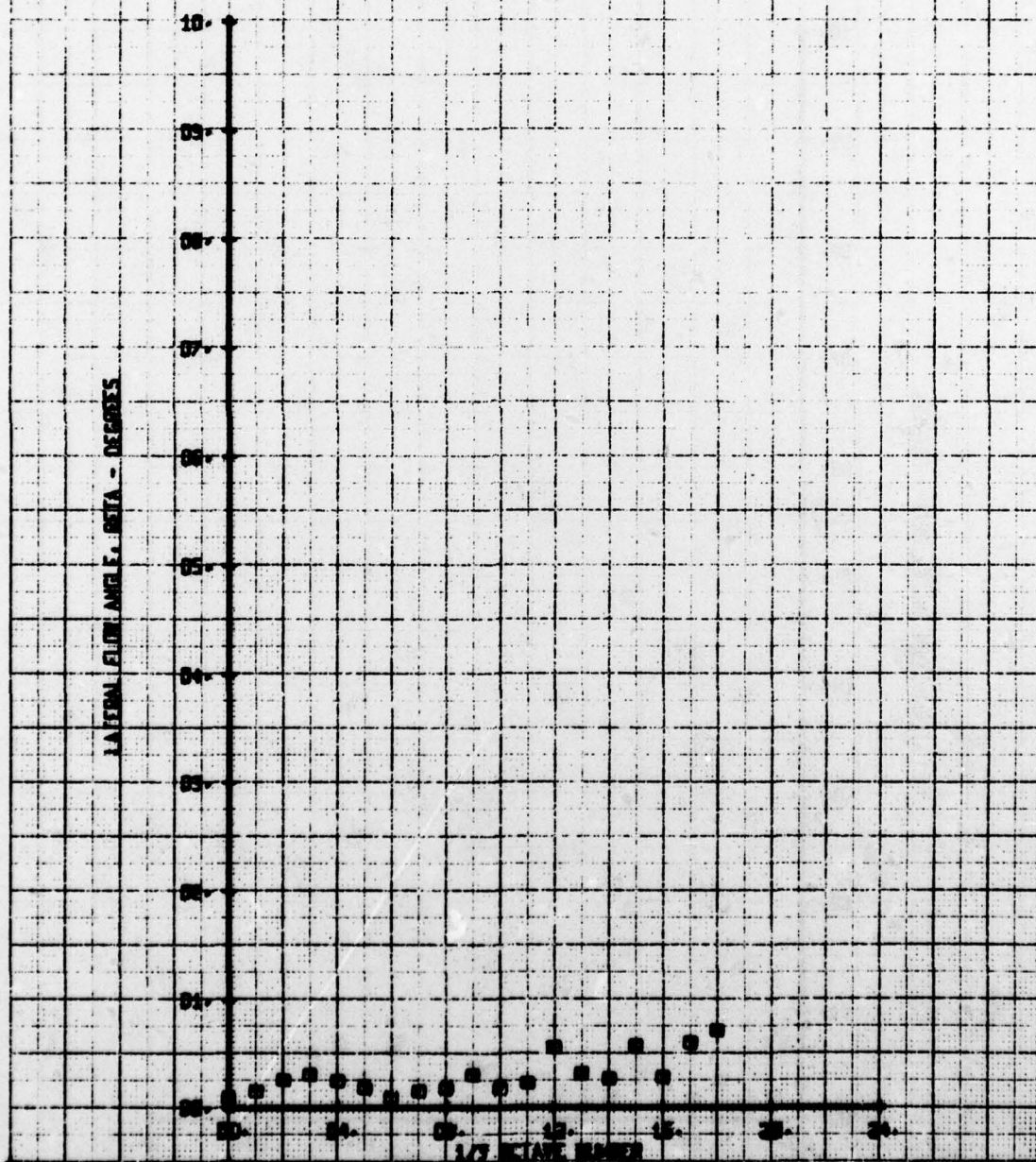
HOT FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE S&U-BLADES OFF, HUB OFF  
 RUN 159 TP 2

SYM  
 0

CH  
 65

LEGEND  
 PARAMETER  
 BETA

LATERAL FLUT ANGLE, BETA - DEGREES

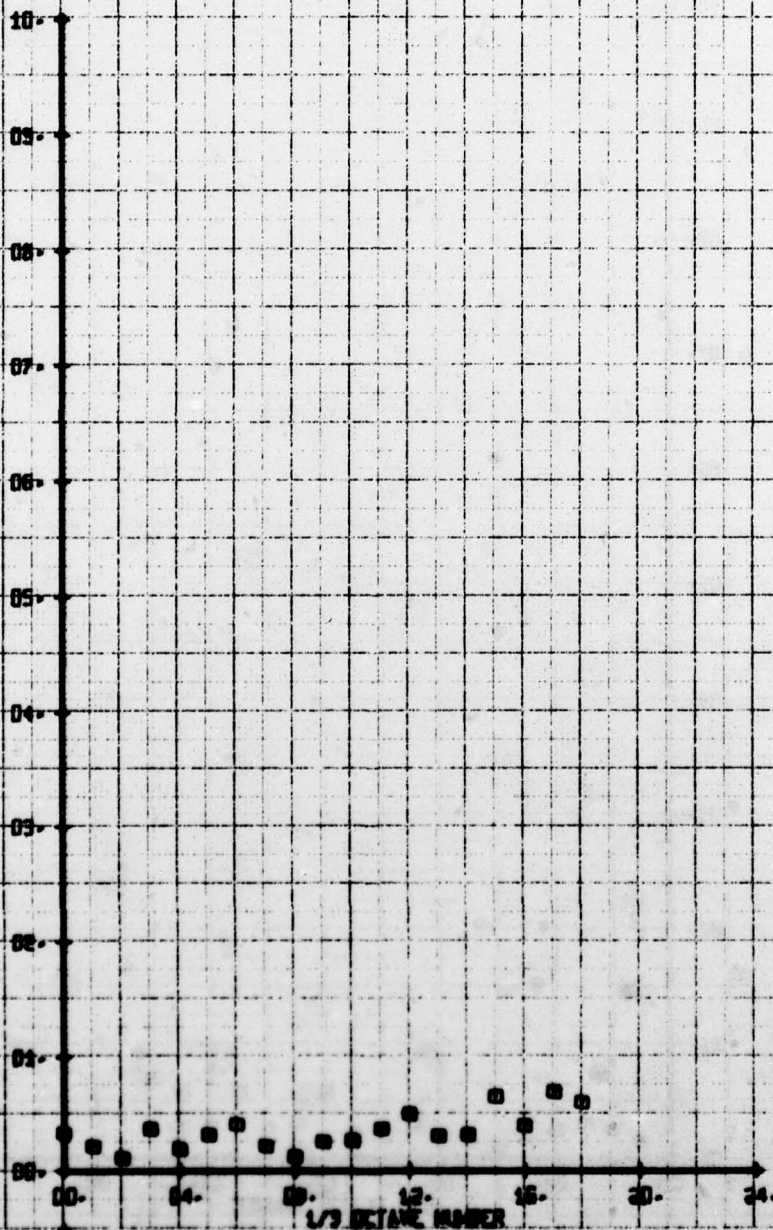




HOT FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE 8-11 BLADES OFF - HUB OFF  
 RUN 199 TP 3

SYM CH PARAMETER  
 @ 65 BETA

LATERAL FLOW ANGLE, BETA - DEGREES



HOT FILM WIRE 1/3 OCTAVE ANALYSIS  
 BASELINE 84U-BLADES OFF, HUB OFF  
 RUN 159 TP 4

SYM  
 □

CH  
 65

LEGEND  
 PARAMETER  
 BETA

LATERAL FLOW ANGLE, BETA - DEGREES

10  
09  
08  
07  
06  
05  
04  
03  
02  
01  
00

1/3 OCTAVE NUMBER

00 04 08 12 16 20 24



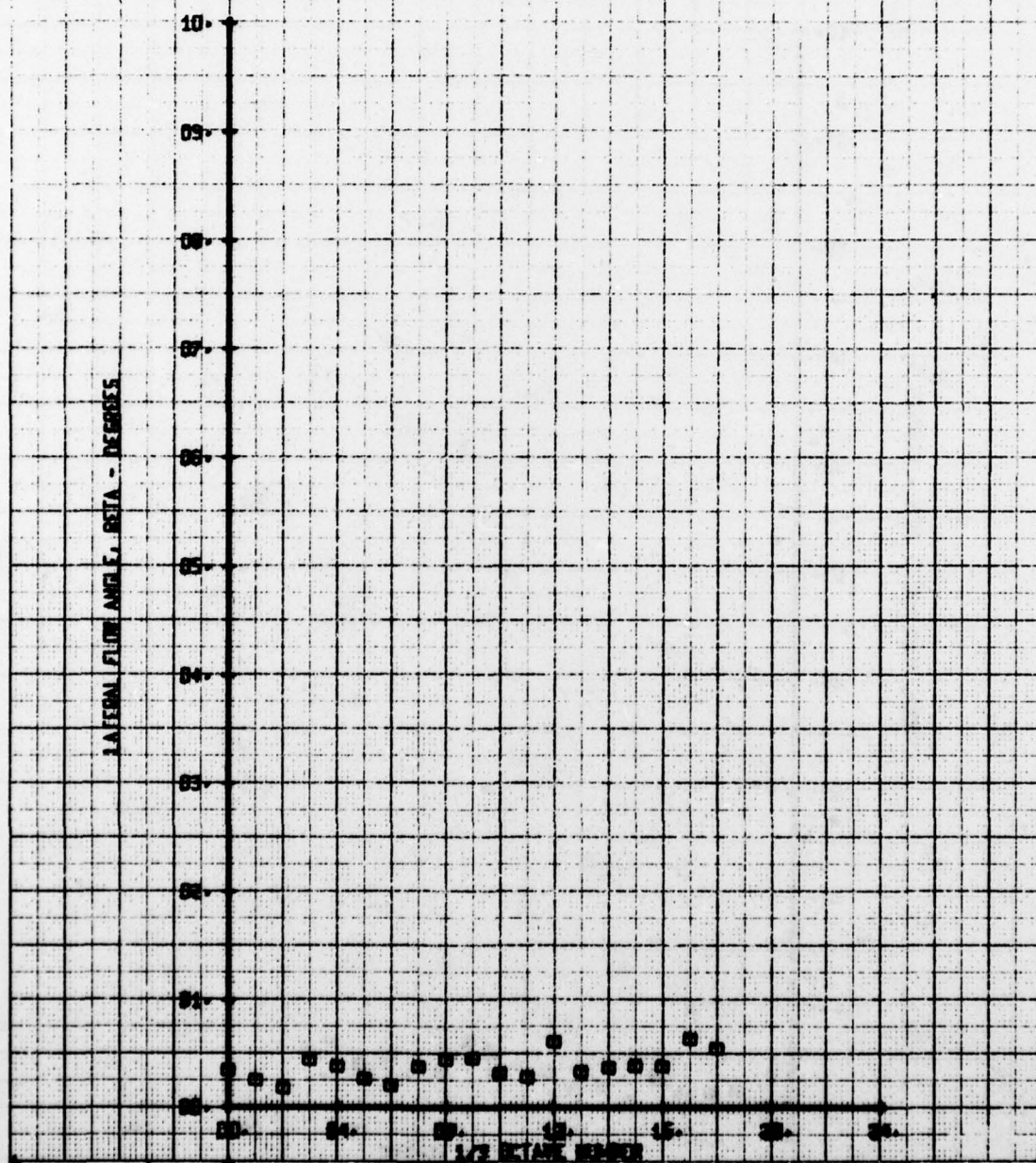
HOT FILM WIRE 1/3 OCTAVE ANALYSIS  
 BASELINE B/U-BLADES OFF, HUB OFF  
 RUN 159 TP 5

SYM  
 □

CH  
 65

LEGEND  
 PARAMETER  
 BETA

LATERAL FLUID ANGLE, BETA - DEGREES



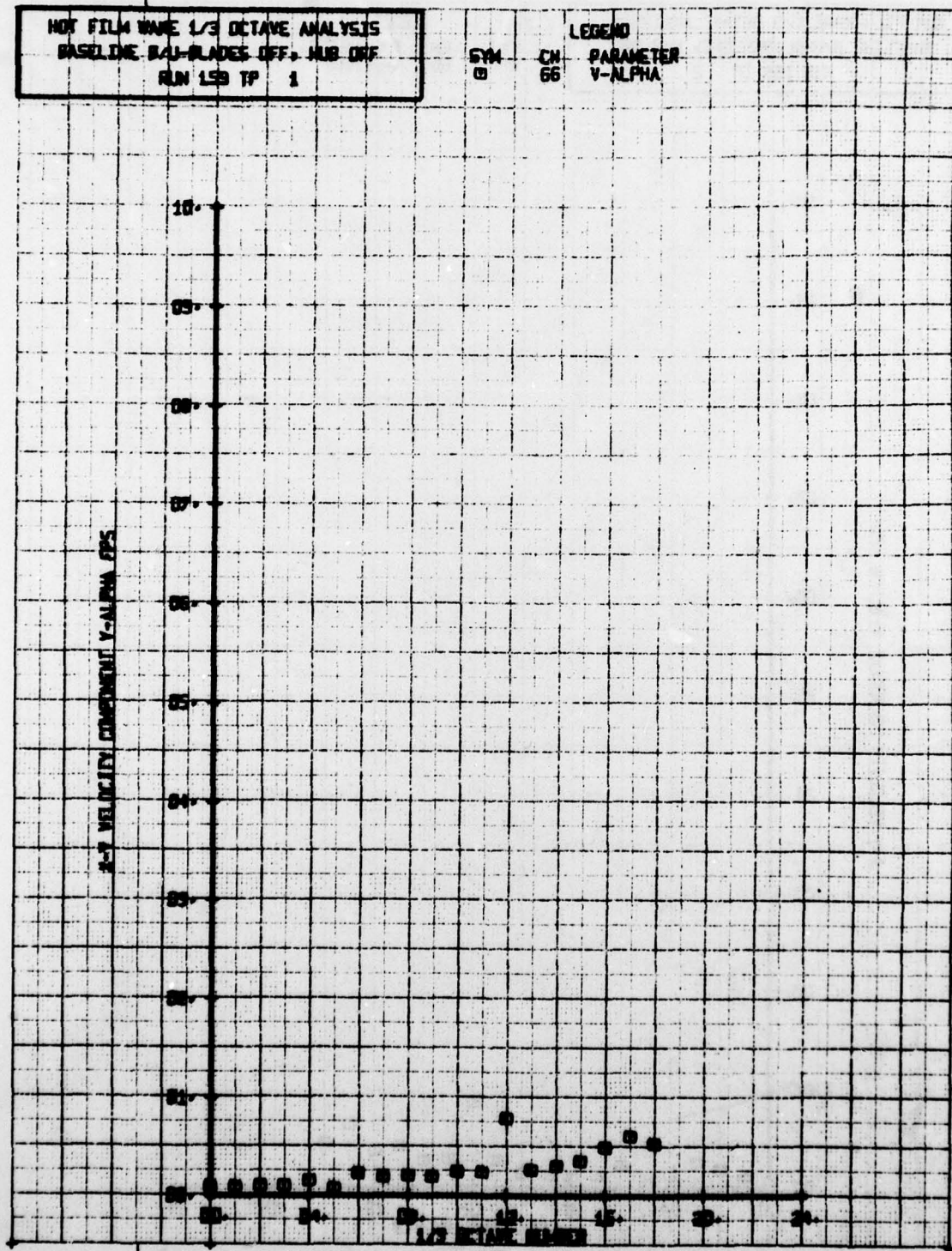
HOT FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE BAL-BLADES OFF, HUB OFF  
 RUN 159 TP 1

SYM  
 0

CN  
 66

LEGEND  
 PARAMETER  
 V-ALPHA

2-V VELOCITY COMPONENT V-ALPHA FPS





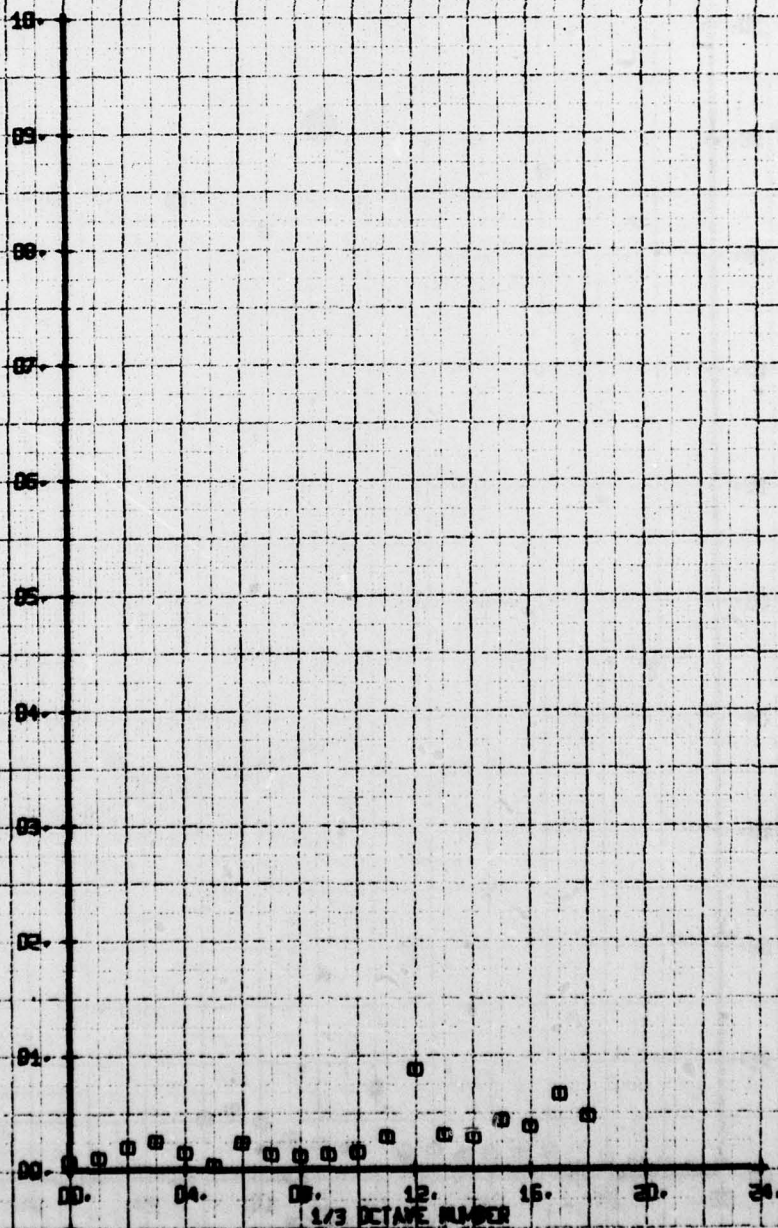
HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE B/A-BLADES OFF, HUB OFF  
 RUN 159 TP 2

SYM  
 0

CH  
 66

LEGEND  
 PARAMETER  
 V-ALPHA

A-Y VELOCITY COMPONENT V-ALPHA RPS



HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE B/U-BLADES OFF, HUB OFF  
 RUN LSB TP 3

SYM  
 □

CH  
 66

LEGEND  
 PARAMETER  
 V-ALPHA

R-Y VELOCITY COMPONENT V-ALPHA FPS

10  
09  
08  
07  
06  
05  
04  
03  
02  
01  
00

1/3 OCTAVE NUMBER

00 05 10 15 20 25



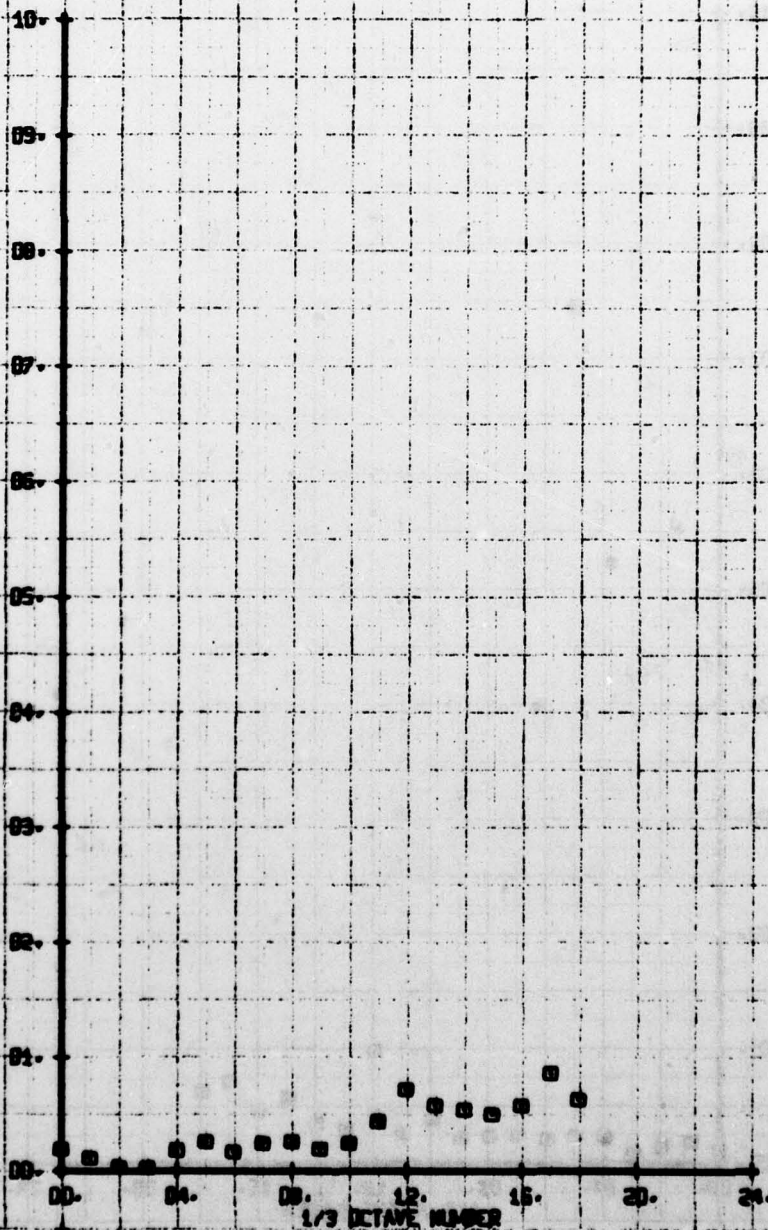
HOT FILM WIRE 1/3 OCTAVE ANALYSIS  
 BASELINE B/U-BLADES OFF, HUB OFF  
 RUN 159 TP 4

SYM  
 01

CN  
 66

LEGEND  
 PARAMETER  
 Y-ALPHA

U-Y VELOCITY COEFFICIENT Y-ALPHA RMS

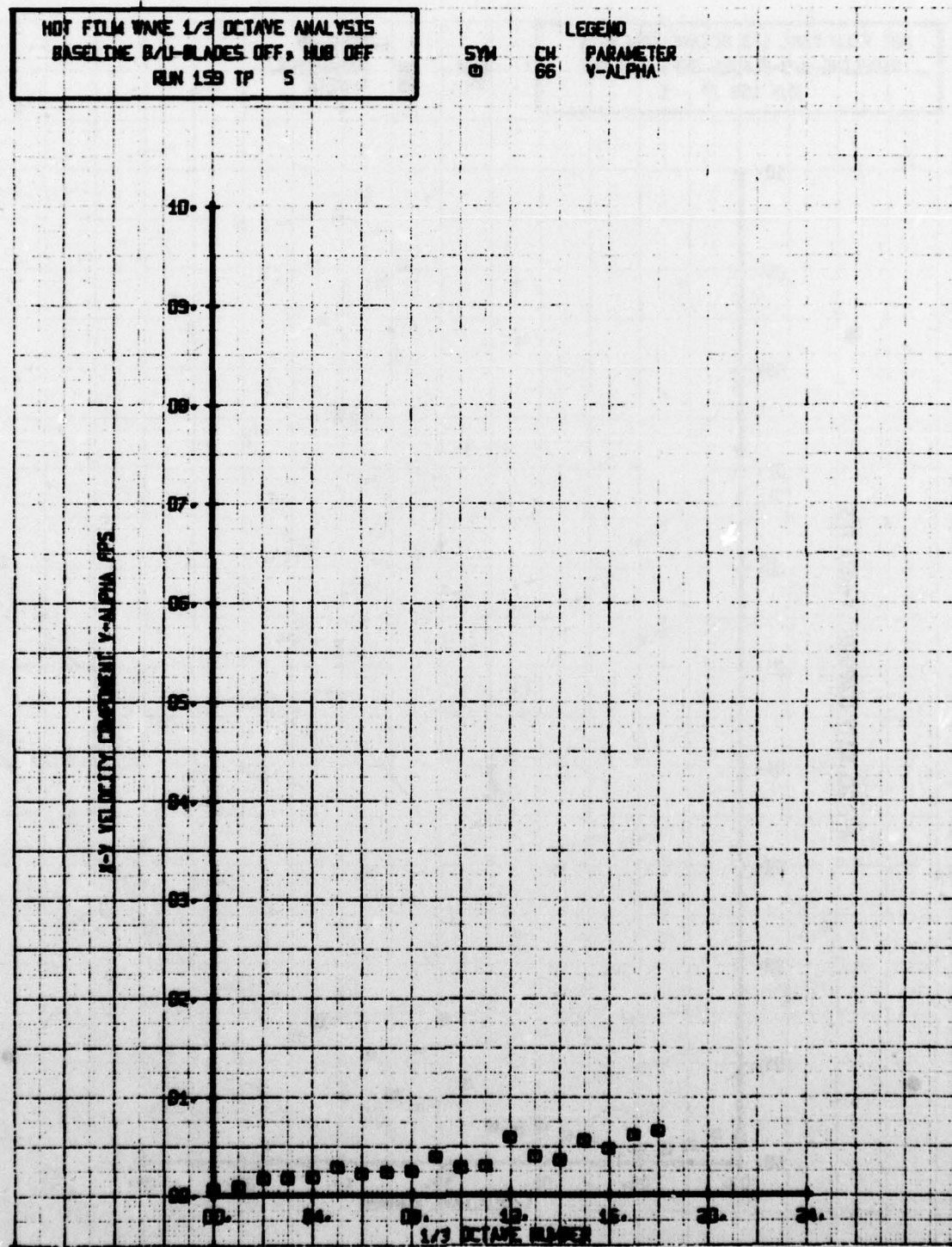


HOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE B/U-BLADES OFF, HUB OFF  
 RUN 159 TP 5

SYM  
 0

CH  
 66

LEGEND  
 PARAMETER  
 V-ALPHA





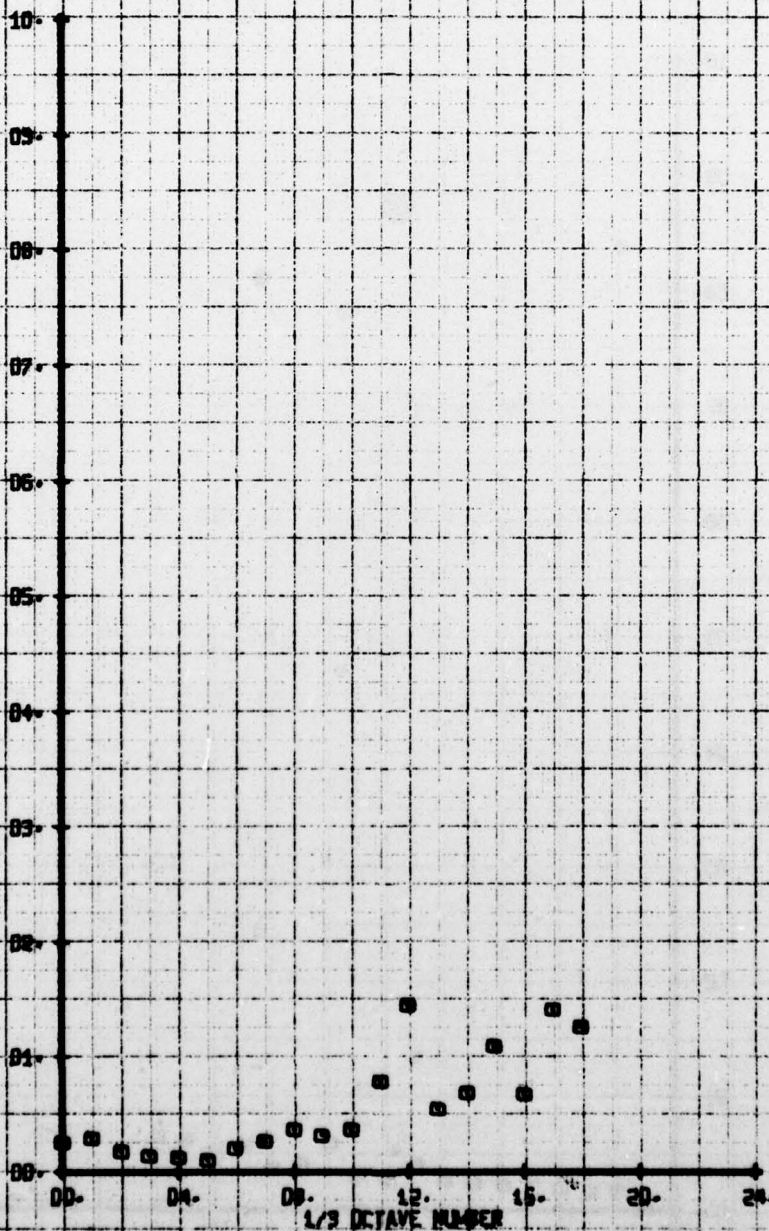
NOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE 8-1-1 BLADES OFF - HUB OFF  
 RUN 158 TP 1

CYN  
 0

CH  
 65

LEGEND  
 PARAMETER  
 V-BETA

A-2 VELOCITY COMPONENT V-BETA FPS



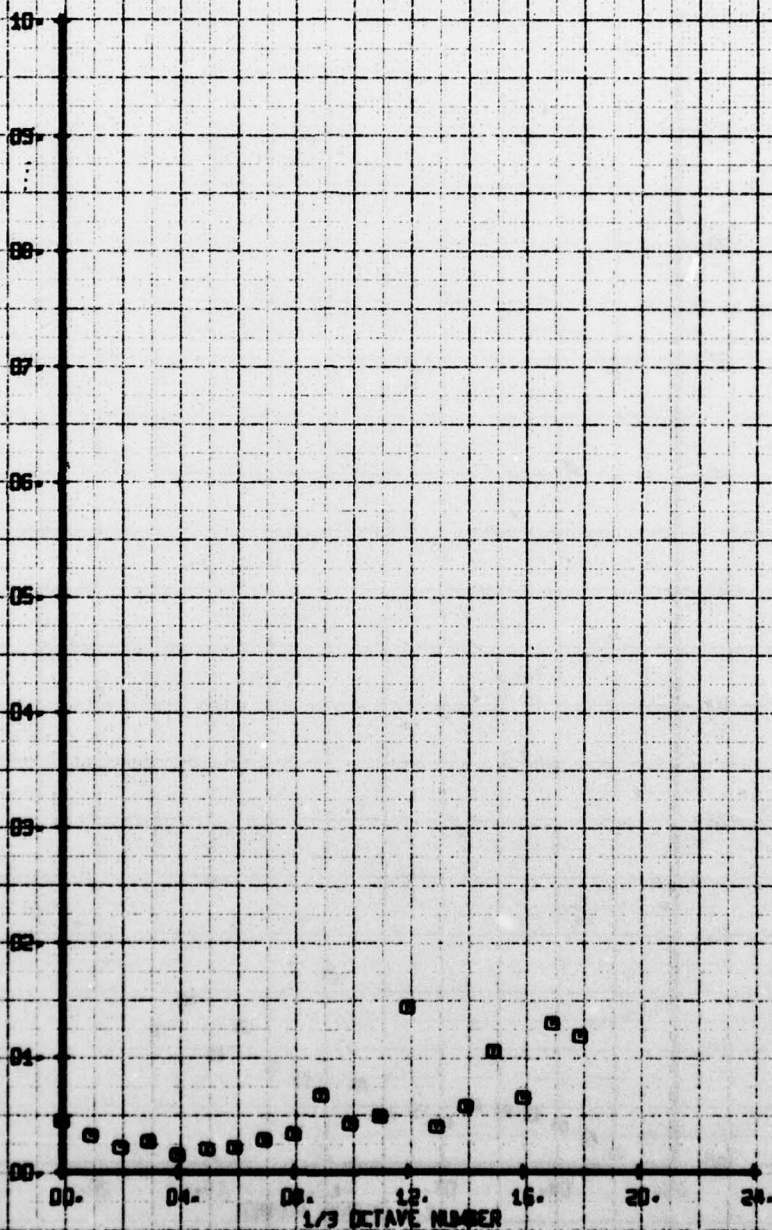
NOT FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE 8/10-BLADES OFF, HUB OFF  
 RUN 159 TP 2

SYM  
 @

CH  
 85

LEGEND  
 PARAMETER  
 V-BETA

A-2 VELOCITY COMPONENT V-BETA FPS





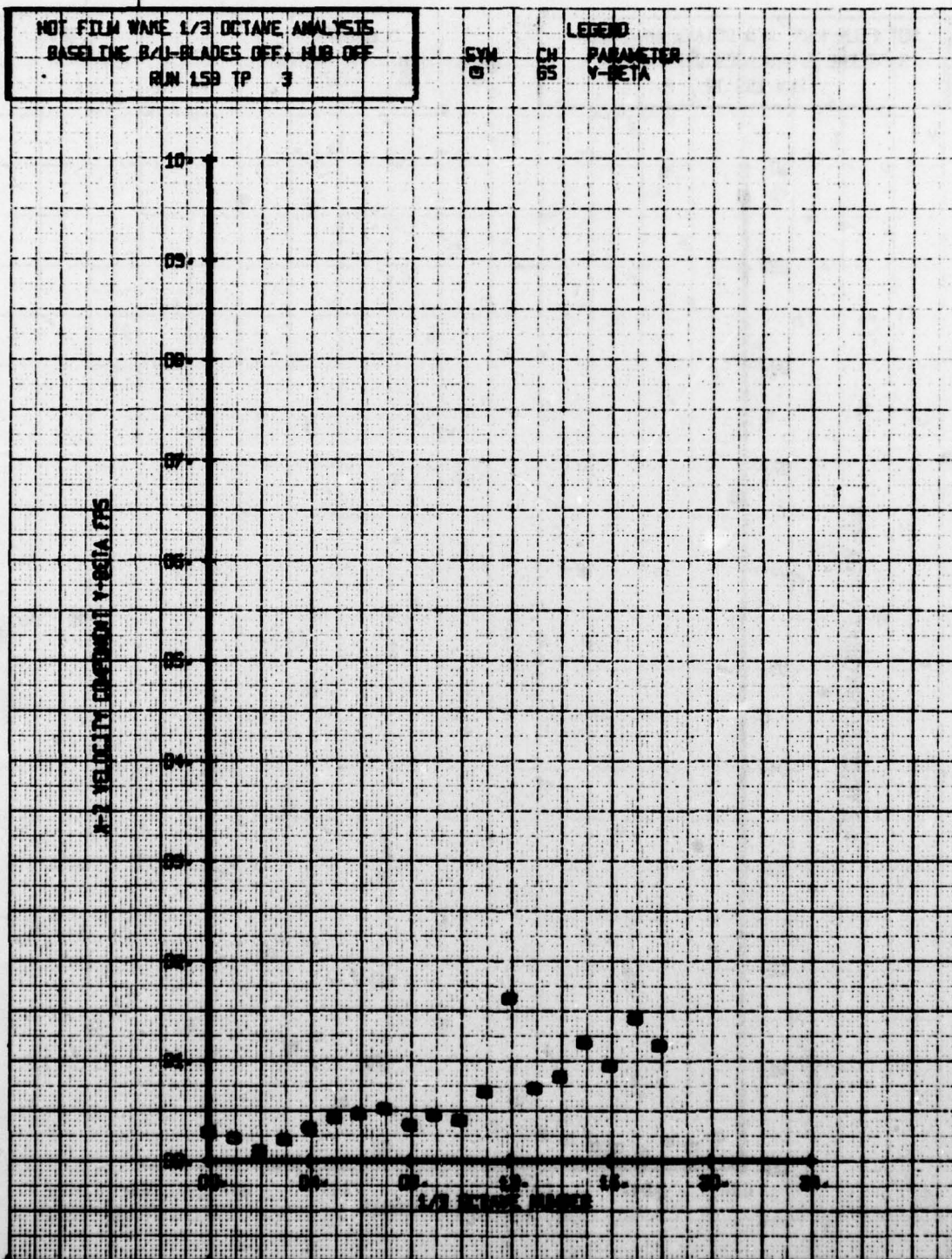
NOT FILM WAKE 1/3 OCTAVE ANALYSIS  
 BASELINE 8/11-BLADES OFF, HUB OFF  
 RUN 159 TP 3

SYM  
 0

CH  
 65

LEGEND  
 PARAMETER  
 V-BETA

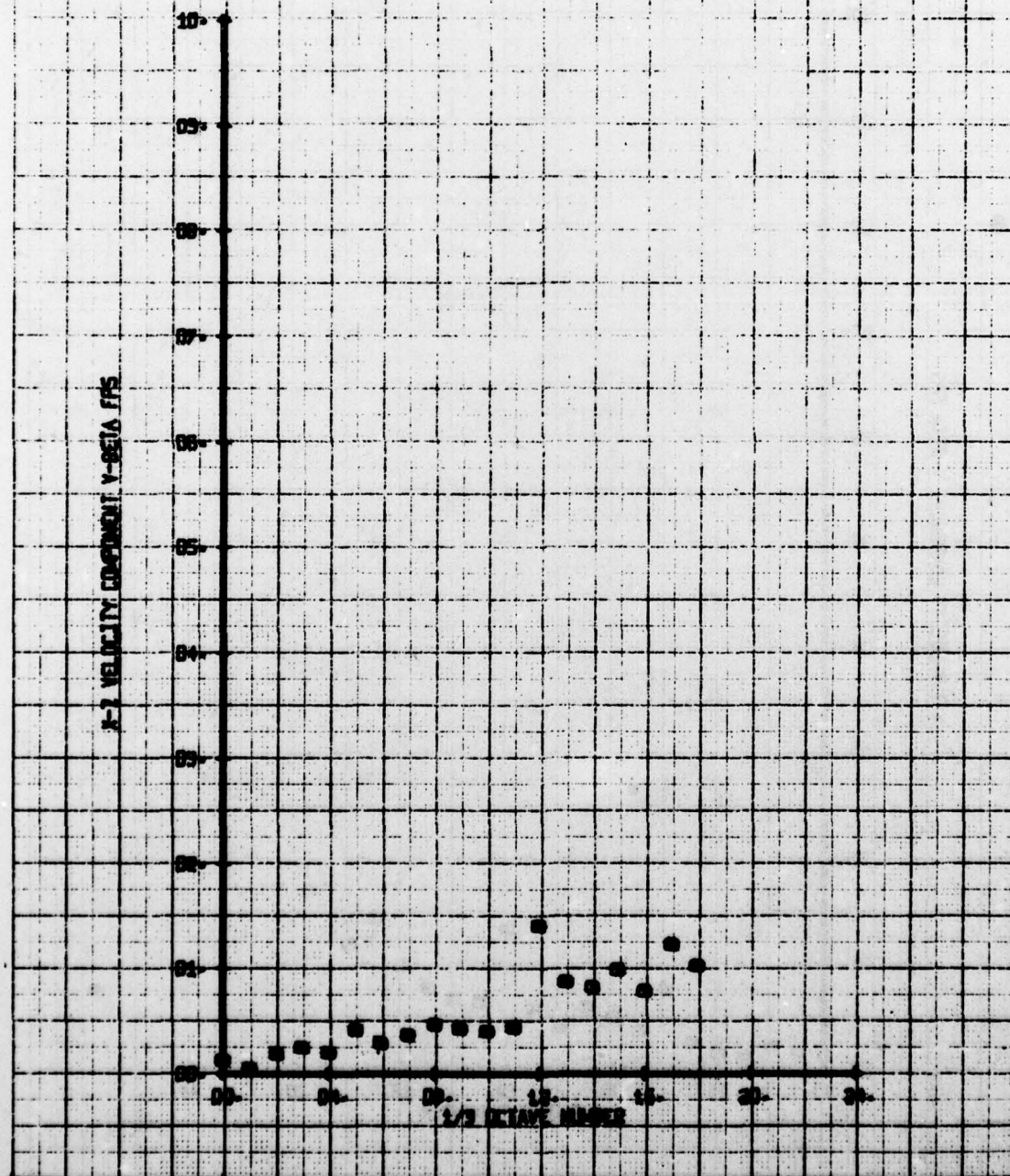
1/3 VELOCITY COMPONENT V-BETA PPS



NOT FILM WAVE 1/3 OCTAVE ANALYSIS  
 BASELINE 8/11-BLADES OFF, HUB OFF  
 RUN LSB TP 4

SYN CH  
 0 65  
 LEGEND  
 PARAMETER  
 V-BETA

X-2 VELOCITY COMPONENT V-BETA FFS





NOT FILM WARE 1/3 OCTAVE ANALYSIS  
 BASELINE 0.4-0.6 HZ OFF - 100 OFF  
 RUN 150 TP 5

SYN CH  
 01 05  
 LEGEND  
 PARAMETER  
 Y-BETA

Y-BETA VELOCITY COMPONENT Y-BETA RMS

